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Acta Botanica Academiae Scientiarum Hungaricae, Tomus 25 (1—2), pp. 1—37 (1979)

NEW NAMES AND NEW SPECIES IN THE FLORA OF CUBA RESP. ANTILLES

By

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(Received 20 January, 1979)

A list of necessary nomenclatural changes concerning the flora of Cuba, some new combinations, a new revised analytical key for classifying the Cuban species of the genus *Ternstroemia* (*Theaceae*) and critical remarks on some Antillean taxa of *Gesneriaceae;* the type specimens of some recently published new taxa of the genera *Harpalyce* (*Fabaceae*), *Amyris* (*Rutaceae*), *Banara* and *Xylosma* (*Flacourtiaceae*) are reported. A critical revision of the *Guapira rufescens* (Griseb.) Lundell (*Nyctaginaceae*) — with descriptions of two species and two varieties new to science.

Introduction

The taxonomical results published during the last 10 years concerning the flora of the Caribbean regions, especially the excellent new Flora of Jamaica by Adams (1972) revised very carefully from a nomenclatural point of view (with the collaboration of T. W. Stearn) and some important monographic studies necessitated rectifying the nomenclatural mistakes and the outworn names applied in the Flora of Cuba and in other works concerning the surrounding Antillean areas. Moreover a few critical remarks have to be made on some monographic studies as well. Additionally the holotype sheets of recently described species of the genera *Harpalyce* (*Fabaceae*), *Behaimia* (*Fabaceae*), *Amyris* (*Rutaceae*), *Ternstroemia* (*Theaceae*), *Xylosma*)*Flacourtiaceae*) and *Gesneria* (*Gesneriaceae*) are also shown in photos.

Potamogetonaceae

Cymodocea manatorum Aschers. = **Cymodocea filiformis** (Kütz.) Correl, according to Correl, Wrightia **4:** 74. 1968.

Cyperaceae

Cyperus diffusus Vahl ssp. **tolucensis** (Kunth) Borhidi **stat. nov.**

Basionymon: *Cyperus tolucensis* Kunth, Nov. Gen. et Spec. 1815: 206. — Syn.: *C. diffusus* var. *tolucensis* (Kunth) Kük. in Engl. — *C. diffusus* ssp. *diffusus* is a South-Asian taxon, does not occur in the Neotropics.

Gramineae

Uniola virgata Griseb. = **Leptochloopsis virgata** (Poir.) Yates
Trichachne insularis (L.) Nees = **Digitaria insularis** (L.) Mez ex Ekman

Palmae

According to the monograph of R. W. READ [The genus *Thrinax* (*Palmae*: *Coryphoideae*) Smiths. Contrib. Bot. No. **12.** 1—98. 1975] two species of *Thrinax* can be found in Cuba: *Thrinax wendlandiana* Becc. and *Thrinax parviflora* auct. non Sw. = **Thrinax radiata** Lodd. ex Schult.
Thrinax drudei Becc. and *Thrinax punctulata* Becc. = **Thrinax morrisii** Wendl.
Haitiella munizii (Borhidi) Borhidi **comb. nova**

Basionymon: *Coccothrinax munizii* Borhidi in Acta Bot. Acad. Scient. Hung. **17:** 2. 1971. The first report of the genus *Haitiella* Bailey from Cuba.

Pseudophoenix sargenti Wendl. is represented in Cuba and in the Greater Antilles by the **ssp. saonae** (O. F. Cook) R. W. Read according to READ in Gentes Herb. **10:** 204. 1968.
Acrocomia armentalis (Morales) Bailey = **Gastrococos crispa** (HBK) H. E. Moore according to H. E. MOORE Principes **11:** 121. 1967, and *Gastrococos* Morales 1865 is a valid monotypic endemic palm genus of Cuba.

Pontederiaceae

Pontederia cordata L. (Cuba); Prov. Pinar del Rio; Rio Hondo, Candelaria. New to Cuba.

Orchidaceae

Epidendrum polybulbon Sw. does not exist in Cuba.
Epidendrum polybulbon auct. Fl. Cub. non Sw. = **Epidendrum cubincola** Borhidi Acta Bot. Acad. Sci. Hung. **22:** 295. 1976.

Piperaceae

Piper arboreum Aubl. ssp. **stamineum** (Miq.) Borhidi **status novus**

Basionymon: *Artanthe staminea* Miq. in Hook. London Journ. Bot. **4:** 461. 1845. — Syn.: *Piper stamineum* C. DC. in Urb. Symb. Ant. **3:** 176. 1902; *Piper arboreum* Aubl. var. *stamineum* (Miq.) Yuncker. This taxon having a vicariant area in Jamaica and Cuba is to be considered as a subspecies of *P. arboreum* Aubl.

Juglandaceae

Juglans insularis Griseb. is a distinct endemic species of Cuba, not identical with *J. jamaicensis* C. DC., as it was suggested by M. WAYNE in Brittonia **12:** 1—26. 1960 and accepted by ALAIN H. LIOGIER in Suppl. Flora de Cuba 1969: 49. According to ADAMS (Flora of Jamaica 1972) *J. jamaicensis* C. DC. is endemic to Jamaica.

Nyctaginaceae

Torrubia Vell. 1825 = **Guapira** Aubl. 1775 according to LUNDELL in Wrightia **4:** 79. 1968 and to LITTLE in Phytologia **17:** 367. 1968. This resulted in a number of nomenclatural changes, as follows:
Torrubia obtusata (Jacq.) Britt. = **Guapira obtusata** (Jacq.) Little
— — *T. obtusata* var. *brachycarpa* (Heimerl) Alain = **Guapira obtusata** var. **brachycarpa** (Heimerl) Alain

— — *T. obtusata* var. *aberrans* (Heimerl) Alain = **Guapira obtusata** var. **aberrans** (Heimerl) Alain
Torrubia discolor (Spreng.) Britt. = **Guapira discolor** (Spreng.) Little
Torrubia leonis Standl. = **Guapira leonis** (Standl.) Lundell
Torrubia longifolia (Heimerl) Britt. = **Guapira longifolia** (Heimerl) Little
Torrubia bracei Britt. = **Guapira bracei** (Britt.) Little
Torrubia fragrans (Dum.-Cours.) Standley = **Guapira fragrans** (Dum.-Cours.) Little
Torrubia insularis Standley = **Guapira insularis** (Standl.) Lundell
Pisonia rotundata Griseb. = **Guapira rotundata** (Griseb.) Lundell
Torrubia rufescens (Griseb.) Britt. = **Guapira rufescens** (Griseb.) Lundell

Guapira rufescens (Griseb.) Lundell s.l.

This species shows a considerable variability in the mountains of the former Provinces of Oriente and Las Villas. A detailed morphological examination based on field and herbarium studies led to the following results:

1 a Leaves ovate, petiole 1.2—2.2 cm long (Cuba; Prov. of Las Villas; Sierra de Escambray, endemic) ..... 1. **Guapira clarensis** Borhidi
b Leaves obovate, elliptic to lanceolate, petiole up to 1 cm long...2
2 a Tree up to 15—20 m height; leaves obovate to spathulate, peduncle up to 15 mm, inflorescence hardly ramified, dense, few-flowered, stamens 6—(7), shortly exerted (Cuba; Prov. of Oriente, North of Oriente) .... 2. **Guapira ophiticola** Borhidi
b Shrubs or little trees; leaves 4—10 cm long, obovate to oblong-lanceolate, peduncles generally 15—30 mm long, inflorescence broadly ramified, manyflowered, stamens 8—9, long exerted (Cuba; North of Oriente, endemic) .... 3. **Guapira rufescens** (Griseb.) Lundell
aa Leaves lanceolate to oblong-lanceolate, tapering into the apex (Cuba; Prov. of Oriente: Sierra de Nipe, Sierra de Cristal, endemic) .... var. **lanceolatus** Borhidi
bb Leaves obovate to oblong-obovate, rounded at the apex .... aaa
aaa Leaves obovate, 4—8 cm long, peduncle 20—30 mm long, anthocarp tapering at the apex (Cuba; North of Oriente, endemic) .... var. **rufescens**
bbb Leaves oblong-obovate, 7—10 cm long, inflorescence short with 10—15 mm long peduncles, anthocarp not tapering into the apex (Cuba; Prov. of Oriente: Moa, endemic) .... var. **moaensis** Borhidi

Guapira clarensis Borhidi sp. n.

Arbor mediocris, 12—15 m alta (ex JACK in schaedis). Rami veteriores albido-flavicantes, longitudinaliter tenuiter striolati, glabri, apicem versus squamulis minutis ferrugineis induti. Folia apice ramorum lateralium brevium opposita vel plerumque conferta, longe et crasse

petiolata. Petiolum 1,2—2,5 cm longum et 0,7—1,8 mm latum, striatum, supra sulcatum, nervo medio in sulco prominenti, squamulis ferrugineis densissime tomentosum. Lamina folii ovata vel elliptica, 3—6 cm longa et 1,5—2,8 cm lata, sub medio latissima, basi obtusa vel in petiolum breviter attenuata, antice rotundata apice ipso minute emarginata, in statu juvenili utrinque ferrugineo-tomentosa, postremo glabrescens; nervo medio supra in sulco prominulo, subtus crassiuscule prominenti, lateralibus utroque latere 7—12 sub angulo 70—80 abeuntibus marginem versus leviter arcuatis, non anastomosantibus, subtus manifeste prominentibus. Cetera ignota.

Holotypus: Cuba; Prov. Las Villas. Sierra de Escambray, prope Buenos Aires in alt. 800—900 m.s.m. Leg.: J. C. JACK 7280 (HAC) 12. apr. 1929.

Guapira ophiticola Borhidi sp. n.

Arbor mediocris vel alta usque ad 15—20 m. Rami veteriores cinerascentes, striati glabri, hornotini squamis minutis ferrugineis densissime obtecti. Folia opposita, 2—6 mm longe petiolata, petiolis dense ferrugineo-tomentosis suffulta, lamina obovata vel spathulata, 1,5—4 cm longa et 1—2,5 cm lata, apice rotundata, basi longe attenuata et cuneata, supra convexa et glabrescens, subtus concava et dense ferrugineo-tomentosa, nervo medio supra applanato, subtus prominenti, lateralibus utrinque obsoletis, margine revoluta, crasse coriacea. Inflorescencia mascula usque ad 15 mm longe pedunculata, capituliformiter contracta, pauciflora, 2—2,5 cm longa. Perianthium 2—2,5 mm longum, denticulis 5, 0,2—0,3 mm longis, dense ferrugineum. Stamina 6—(7), filamenta basi in tubo inserta, 2—2,5 mm longa, antherae orbiculari cordiformes, 0,5 mm longae, medio affixae, e tubo brevissime exsertae. Ovarium rudimentarium 0,5 mm longum, stylus 1 mm longus, apice truncatus vel deficienter penicillato-ramificatus. Inflorescentia feminea (vide paratypum) 2—2,5 cm longa, 10—15 mm longe pedunculata, capitulata vel breviter racemosa. Perianthium tubulosum, apice basique attenuatum, 3,5—4 mm longum, dense ferugineo- vel rufo-tomentosum, denticulis 5, brevissimis. Ovarium 2 mm longum, stylus 2 mm longus, paullo exsertus, apice penicillato-racemosus, Staminodia 6, inaequilonga, ovarium non superantia. Fructus non visus.

Holotypus: ALAIN 5436 HAC; Cuba; Prov. Oriente. Sierra del Cristal, Saca La Lengua. Leg.: ALAIN, ACUÑA et LÓPEZ FIGUEIRAS, 2—7. apr. 1956. Isotypus: HAC.

Paratypus: ACUÑA et ZAYAS 19659; Cuba; Prov. Oriente; Sierra del Cristal, Nicaro; Area named formerely as "Montes of United Fruit". Leg. ACUÑA et F. ZAYAS, 26—27. Mai. 1955. HAC Flor. fem.

Specimina examinata: Sierra de Nipe: Charrascal de la Cueva, Pinares de Mayari. Leg.: LÓPEZ FIGUEIRAS 2515 HAC! 25. febr. 1956 (ster.) — Sierra del Cristal: Saca La Lengua Leg.: A. BORHIDI, M. VALES, R. OVIEDO 11 apr. 1976. — Entre Los Mulos y Corea in alt. 700—800 m.s.m. M. LÓPEZ FIGUEIRAS UO 220 (HAC) — Sierra de Moa: Breñales de la Playa de Vaca, Moa, Leg.: ACUÑA 13096 HAC(SV), 9. nov. 1945 (ster.) — Ibidem, ACUÑA 12412 HAC(SV) 11. apr. 1945. (ster.) — Monte La Breña, Moa. Leg.: CLEMENTE et CRISÓGONE 4420 HAC(LS), 24. jun. 1945. (flor. fem.)

Obs.: *Pisonia rufescens* (Griseb.) f. *parvifolia* Urb. et Heimerl (Syn.: *Torrubia rufescens* f. *parvifolia* (Urb. et Heimerl) Alain) non *Torrubia parvifolia* Standl. nec *Guapira parvifolia* (Standl.) Lundell secundum specimen typicum EKMAN 9589, Sierra de Nipe, Via Bio (S) huc pertinet.

Guapira rufescens (Griseb.) Lundell

var. *rufescens*: foliis obovatis, 4—8 cm longis, antice rotundatis, inflorescentia elongata, cymoso-corymbosa, multiflora, pedunculus 20—30 mm longus, anthocarpium 6—9 mm longum, apice attenuatum.

var. lanceolatus Borhidi var. n.

Rami hornotini ferrugineo-tomentosi, veteriores glabrescentes, striati, albi. Folia opposita, 5—10 mm longe petiolata, lanceolata, oblanceolata vel lineari-lanceolata, 6—14 cm longa, 1,5—2,5(—3,5) cm lata, latitudine 4—5-plo longiora, leviter obliqua, apice longe attenuata et obtusa, basi longe cuneata et in petiolum protracta, subtus ferrugineo-tomentosa, postremo glabrescentia vel glabra, margine irregulariter crenulato-undulata, coriacea; nervo medio supra impresso, subtus valde prominenti, lateralibus supra inconspicuis vel obsoletis, subtus leviter prominulis, marginem versus arcuatis, obsolete anastomosanti-reticulatis. Flos fructusque non visi.

Typus: UO 1024. Cuba; Prov. Oriente; Sierra de Nipe, Pinares de Mayari, Charrascal de la Cueva. Leg.: LÓPEZ FIGUEIRAS 27—31. Mai. 1960. HAC! Isotypi: HAC, HAJB.

Specimina examinata: Sierra del Cristal: Rio Lebisa in alt. 570—660 m. sm. Leg.: LÓPEZ FIGUEIRAS 26. aug. 1959. — Sierra del Cristal: Cayo Verde; Leg.: ALAIN 4530; 26. dec. 1955. — Falda Sur del Pico del Cristal; leg.: ALAIN 4741; 28. dec. 1955. — Ibidem, leg.: A. BORHIDI et M. VALES 12. apr. 1976.

var. moaensis Borhidi var. n.

A typo differt foliis oblongo-obovatis. 7—11 cm longis, latitudine 2—3-plo longioribus inflorescentiis femineis brevibus, 2—4 cm longis, breviter ramificatis, pedunculis 10—20 mm longis, anthocarpio 8—11 mm longo, apice rotundato vel truncato,

Typus: Cuba; Prov. Oriente; Región de Moa: Charrascal del Coco, Leg.: LEÓN, ALAIN, CLEMENTE et CRISÓGONE 22642 HAC, 3. aug. 1945. (fruct.). Isotypus: HAC.

Specimen examinatum: Ibidem, CLEMENTE 4749, aug. 1945. verisimiliter isotypus.

Mimosaceae

Albizzia berteriana (Balb.) Gómez de la Maza = **Pseudalbizzia berteroana** (Balb. ex DC.) Britt. et Rose

Pithecellobium arboreum auct. cub. pro majore parte, non (L.) Urb. = **Pithecellobium cubense** Bisse in Ciencias ser. 10. Botánica Univ. Habana No. 2: 6—7. 1975.

Caesalpiniaceae

Caesalpinia violacea (Mill.) Steud. = **Peltophorum linnaei** Benth. et Hook.

Fig. 1. Holotype specimen of *Harpalyce cristalensis* Borhidi et Muñiz (ACUÑA 19671)

Fabaceae

A taxonomic study on the Cuban species of the genus *Harpalyce* has recently been published — BORHIDI, A.—MUÑIZ, O.: Adiciones al conocimiento de la flora cubana (I). Ciencias Biológicas Acad. Cien. Cuba 1 : 131—145. 1977. — with a new analytic key and descriptions of 8 species and 2 varieties new to science.

Harpalyce cristalensis Borhidi et Muñiz in Ciencias Biologicas Acad. Cien. Cuba 1 : 133—134. 1977. (Fig. 1.)

Holotype: ACUÑA 19761 HAC; Cuba: Sierra del Cristal; Saca La Lengua. Coll.: J. ACUÑA and F. ZAYAS 26—27. May, 1955.

Harpalyce borhidii Muñiz l.c. p. 134—135. (Fig. 2.)

Holotype: López Figueiras 2504 HAC; Sierra de Nipe; Charrascal de La Cueva, Pinares de Mayari, 25. Febr. 1956. Isotypes: HAC(LS), BP, HAJB. This species was confused with the specimens of *H. villosa* Britt. and Wilson (Fig. 3.)

Fig. 2. Holotype specimen of *Harpalyce borhidii* Muñiz (LF 2504)

Harpalyce cubensis Griseb. var. *cajalbanensis* Borhidi et Muñiz l.c. p. 136.

Holotype: Acuña 15061 HAC; Prov. of Pinar del Rio: Charrascales of Cajalbana.

Harpalyce flexuosa León et Alain ex Borhidi et Muñiz l.c. p. 136. (Fig. 4.)

Holotype: León 11971 HAC; Prov. of Oriente: Sierra de Imias. Alto de la Mesa de Prada, Jauco. 17. July—4. Aug. 1924. Isotype: HAC.

Harpalyce foliosa Borhidi et Muñiz l.c. p. 136. (Fig. 5.)

Holotype: Alain 3075 (HAC); Cuba; Province of Oriente; in forests of Palenquito de Yateras in alt. approx. 550 m.a.s.l. Collected by Alain July 20, 1953. Isotype: HAC.

Harpalyce acunae Borhidi et Muñiz l.c. p. 137. (Fig. 6.)

Holotype: López Figueiras 1722 HAC(LS 13525); Sierra de Nipe; Finca La Caridad. 26. Nov, 1957. Isotypes: HAC, HAJB.

Harpalyce nipensis Urb. var. *lanceolatus* Borhidi et Muñiz l.c. p. 137—138.

Holotype: Alain 5880 HAC; Sierra de Cristal; Rio Miguel, in evergreen serpentine scrub. Collected by Alain, Acuña and López Figueiras, 2—7 Apr. 1956. Isotypes: HAC, HAJB.

Fig. 3. Representative specimen of *Harpalyce villosa* Britt. et Wils. (León 20772)

Harpalyce toaensis Borhidi and Muñiz l.c. p. 138. (Fig. 7.)

Holotype: Alain 3168 HAC; Prov. Oriente: Cuchillas de Toa; in pine forests of Peña Prieta, La Magdalena, Toa; alt. approx. 600 m.a.s.l. Collected by Alain H. Liogier, 22. July, 1953. Isotype: HAC(LS 13526). This species was formerly classified as *H. alainii* León, which can be distinguished easily by much larger leaflets, shorter peduncled inflorescences and much longer pedicelled flowers (Fig. 8.).

Harpalyce moana Borhidi and Muñiz l.c. p. 138—139. (Fig. 9.)

Holotype: HAC 26819; Prov. of Oriente; Mina Potosi, Moa. Collected by V. Samek, May. 1968.

Harpalyce baracoënsis Borhidi and Muñiz l.c. 139. (Fig. 10.)

Holotype: UO 814 in HAC; Prov of Oriente; Charrascal de Cuaba, Baracoa. Collected by López Figueiras, 14. April, 1960. Isotypes: LS 19734; HAJB.

Pictetia marginata auct. cub. p. p. non Sauv. = **Pictetia cubensis** Bisse in Ciencias Univ. Habana Ser. 10. Botánica No. 2: 9. 1975.
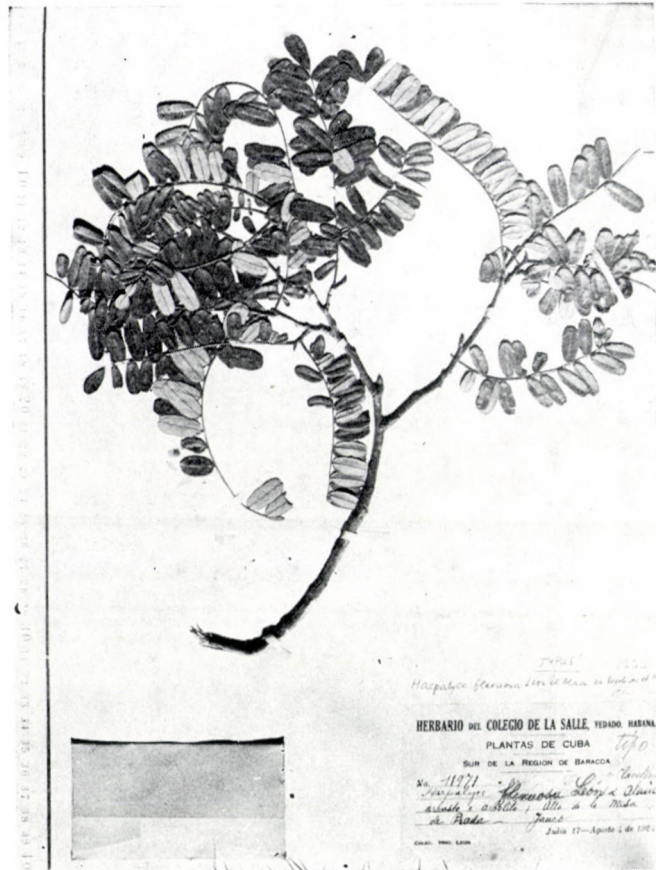
Fig. 4. Holotype specimen of *Harpalyce flexuosa* León et Alain ex Borhidi et Muñiz (León 11971)

Pictetia spinifolia auct. cub. p. p. non (Desv.) Urb. = **Pictetia arborescens** Borhidi, Acta Agron. Acad. Sci. Hung. **27:** 431. 1978.

Belairia ternata Wr. in Griseb. = **Belairia angustifolia** (Griseb.) Borhidi

Belairia mucronata auct. cub. p. p. non Griseb. = **Belairia savannarum** Bisse l.c. p. 11.

Brya buxifolia auct. Fl. Cub. non Urb. = **Brya hirsuta** Borhidi in Acta Bot. Acad. Sci. Hung. **22:** 301. 1976.

Brya ebenus (L.) DC. is an endemic soft leafed deciduous shrub, which probably does not occur in Cuba. The related Cuban populations belong to a number of species, some of them not described yet (according to Bisse l.c. p. 8—9). A recently described species of this taxonomic range is *Brya microphylla* Bisse l.c. p. 8.

Behaimia roigii Borhidi in Acta Agron. Acad. Sci. Hung. **27:** 430. 1978 is an interesting new tree species with leaves composed of numerous little leaflets, of the endemic Cuban genus *Behaimia* until now known as a monotypic one (Figs 11—12).
Goeffroea inermis W. Wright = **Andira inermis** (W. Wright) DC.

Fig. 5. Harpalyce foliosa Borhidi et Muñiz, holotype specimen (ALAIN 3075)

Erythrina leptopoda auct. Fl. Cub. non Urb. et Ekm. = **Erythrina acunae** Borhidi in Acta Agron. Acad. Sci. Hung. **27:** 430. 1978.
Dolichos Lablab L. = **Lablab purpureus** (L.) Sweet

Rutaceae

The generic name *Fagara* L. is to be maintained as "nomen conservandum". In consequence of this all combinations of the former Cuban *Zanthoxylum* species have been changed:
Zanthoxylum taediosum A. Rich. = **Fagara taediosa** (A. Rich.) Kr. et Urb.

Zanthoxylum coriaceum A. Rich. = **Fagara coriacea** (A. Rich.) Kr. et Urb.
Zanthoxylum Fagara (L.) Sarg. = **Fagara pterota** L.
Zanthoxylum Elephantiasis Macf. = **Fagara elephantiasis** (Macf.) Kr. et Urb.
Zanthoxylum martinicense (Lam.) DC. = **Fagara martinicensis** Lam.

Fig. 6. Holotype specimen of *Harpalyce acunae* Borhidi et Muñiz (LF 1722)

Zanthoxylum pistacifolium (Griseb.) = **Fagara pistacifolia** (Griseb.) Kr. et Urb.
Zanthoxylum nannophyllum (Urb.) Alain = **Fagara nannophylla** Urb.
Zanthoxylum curbeloi Alain in Contrib. Ocas. Mus. Hist. Nat. Col. de La Salle Habana No. **9:** 23. 1950. = **Fagara curbeloi** (Alain) Kereszty **comb. n.**
Zanthoxylum lomincolum (Urb.) Alain = **Fagara lomincola** Urb.
Zanthoxylum shaferi P. Wils. in North. Amer. Fl. **25:** 182. 1911 = **Fagara shaferi** (P. Wils.) Kereszty **comb. n.**
Zanthoxylum acuminatum Sw. = **Fagara acuminata** Sw.
Zanthoxylum cubense P. Wils. = **Fagara juglandifolia** Kr. et Urb.

Zanthoxylum pimpinelloides (Lam.) DC. = **Fagara pimpinelloides** Lam.
Zanthoxylum spinosum (L.) Sw. = **Fagara spinosa** (L.) Sw.
Zanthoxylum phyllopterum (Griseb.) Wr. = **Fagara phylloptera** Griseb.
Zanthoxylum dumosum A. Rich. = **Fagara dumosa** (A. Rich.) Griseb.

Fig. 7. Holotype specimen of *Harpalyce toaensis* Borhidi et Muñiz (Alain 3168)

Zanthoxylum acunai Alain in Contr. Ocas. Mus. Hist. Nat. Col. de La Salle No. **9:** 22. 1950 = **Fagara acunai** (Alain) Borhidi et Kereszty **comb. n.**
Zanthoxylum spinifex (Jacq.) DC. = **Fagara spinifex** Jacq.
Zanthoxylum leonis Alain in Contr. Ocas. Mus. Hist. Nat. Col. de la Salle No. **9:** 23. 1950 = **Fagara leonis** (Alain) Kereszty **comb. n.**
Zanthoxylum ekmanii (Urb.) Alain = **Fagara ekmanii** Urb.
Zanthoxylum duplicipunctatum Wr. ex Griseb. = **Fagara duplicipunctata** (Wr. ex Griseb.) Kr. et Urb.
Zanthoxylum organosium (Urb.) Alain = **Fagara organosia** Urb.

Zanthoxylum dictyophyllum (Urb.) Alain = **Fagara dictyophylla** Urb.
Zanthoxylum flavum Vahl = **Fagara flava** (Vahl) Kr. et Urb.
Amyris lineata Wr. ex Griseb. sensu León and Alain (Flora de Cuba, **2:** 394. 1951) was proved to be a species complex, which can be separated into three well defined taxa (see BORHIDI and
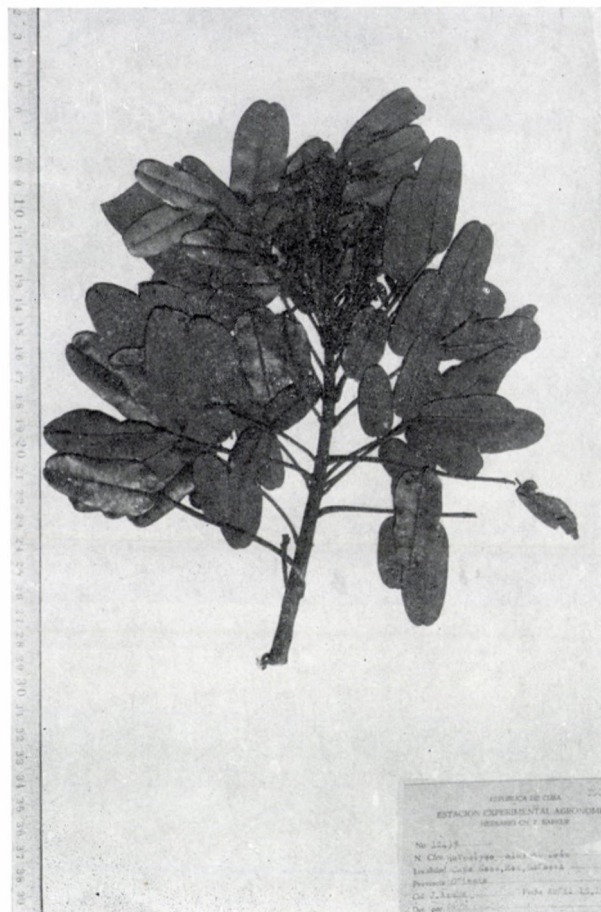
Fig. 8. Isotype specimen of *Harpalyce alainii* León (ACUÑA 12439)

KERESZTY in BORHIDI, A.—IMCHANITSKAYA, N.—MUÑIZ, O.: Acta Agron. Acad. Sci. Hung. **27:** 431—432. 1978) as follows:
Amyris lineata Wr ex Griseb. s. str. Type: Wr. 1154! in HAC isotype! Fig. 13.
Amyris maestrensis Borhidi et Kereszty l.c. p. 432. Fig. 14.

Holotype: Cuba; Sierra Maestra, in montane rain forests of Loma del Gato, alt. approx. 1000 m.a.s.l. Collected by CLEMENTE No. 5156, dec. 1946. Isotype: BP.

Amyris verrucosa Borhidi et Kereszty l.c. p. 432. Fig. 15.

Holotype: Cuba; Sierra de Escambray; Lagunas de Buenos Aires, in alt. approx. 800 m.a.s.l. Collected by J. G. JACK Nr. 7893. 9. April, 1930. HAC!. Isotype: BP!

Meliaceae

Trichilia havanensis Jacq. is a good species, not identical with *T. glabra* L., as it was contributed by ALAIN H. LIOGIER (Suppl. Flora de Cuba 1969: 84).

Fig. 9. Harpalyce moana Borhidi et Muñiz, holotype specimen (26819 HAC)

Malpighiaceae

Byrsonima spicata auct. cub. non (Cav.) L. C. Rich. = **Byrsonima coriacea** (Sw.) Griseb.
Byrsonima lucida auct. Fl. Cub. p. p. non DC. = **Byrsonima orientensis** Bisse l.c. 13.

Euphorbiaceae

Phyllanthus cuneifolius (Britt.) Croiz. = **Securinega cuneifolia** (Britt.) Webster
Croton L. A new taxonomic revision of the Cuban species of the genus *Croton* was published by A. BORHIDI and O. MUÑIZ in Annales Hist.-Nat. Mus. Nation. Hung. Budapest **69:** 41—53

(1977) with the descriptions of 11 new species and 4 new combinations furthermore with a completed description of some insufficiently known species.
Acidocroton oligostemon auct. Fl. Cub. p. p. non Urb. from the serpentine barrens of the Prov-

Fig. 10. Holotype specimen of *Harpalyce baracoënsis* Borhidi et Muñiz (UO 814 HAC)

ince Las Villas = **Acidocroton acunae** Borhidi and Muñiz in Acta Bot. Acad. Sci. Hung. **22:** 305. 1976.
Platygyne Merc. A revision of this genus was published by BORHIDI (Annales Hist.-Nat. Mus. Nation. Hung. Budapest **64:** 89—94) with description of two new species. ALAIN H. LIOGIER suggested (1971) to including *Platygyne* into the genus *Tragia*. Based on comparative pollen morphologic studies *Platygyne* seems to be a separate, endemic genus of Cuba.
Omphalea commutata Muell. Arg. Cuba: Prov. of Guantánamo: Maisi; Hispaniola. New to Cuba; according to ALAIN H. LIOGIER in Mem. New York Bot. Gard. 21(2). 1971.
Ditta Griseb. A new species of *Ditta* was recently described from the Sierra Maestra, Cuba by

BORHIDI in Acta Agron. Acad. Sci. Hung. **27** 433. 1978.
Ditta maestrensis Borhidi (*D. myricoides* León et Alain p. p. non Griseb.). Holotype: LEÓN 10883 in HAC (LS); isotypes 10884 LEÓN in HAC(LS) and in NY; fig. 36. LEÓN and ALAIN: Flora de Cuba **3:** 112.

Fig. 11. Isotype specimen of *Behaimia cubensis* Griseb. (WRIGHT 3383 in Herb. Sauvalle, HAC)

Gymnanthes species of the West Indies belong to the genus **Ateramnus** P. Brown, according to ROTHMALER in Feddes Repert. **53:** 5. 1944 (see ADAMS: Flora of Jamaica as well), and due to this fact it is necessary apply following nomenclatural changes:
Actinostemon brachypodus (Griseb.) Urb. = **Ateramnus brachypodus** (Griseb.) Rothm.
Gymnanthes lucida Sw. = **Ateramnus lucidus** (Sw.) Rothm.
Gymnanthes albicans (Griseb.) Urb. = **Ateramnus albicans** (Griseb.) Rothm.
Gymnanthes glandulosa (Sw.) Muell. Arg. = **Ateramnus glandulosus** (Sw.) Adams
Gymnanthes recurva Urb. = **Ateramnus recurvus** (Urb.) Rothm.

Two other taxa of *Gymnanthes* having very latescent tissues, male and female calyx with 2—3 well developed lobes, belong to the genus *Sapium*. For this reason:

Gymnanthes pallens (Griseb.) Muell. Arg. = **Sapium pallens** (Griseb.) Borhidi **comb. n.** — Basionymon: *Excoecaria pallens* Griseb. in Mem. Amer. Acad. nov. ser. **8:** 161. 1861.
Gymnanthes pallens var. *tenax* (Griseb.) Muell. Arg. = **Sapium pallens** (Griseb.) Borhidi var. **tenax** (Griseb.) Borhidi **comb. n.** — Basionymon: *Excoecaria tenax* Griseb. in Goett. Nachr. 1865: 179. Syn.: *Sapium parvifolium* Alain in Rev. Soc. Cub. Bot. **10:** 27. 1953.

Fig. 12. Holotype specimen of *Behaimia roigii* Borhidi (7482 HAC)

Mettenia Griseb.

According to Jamaican authors (FAWCETT and RENDLE, ADAMS) there is no essential morphological difference between the Antillean genus *Mettenia* Griseb. and the pantropical genus *Chaetocarpus* Thwaites. This results in that the earlier generic name *Chaetocarpus* is valid for the Antillean species as well, with the following nomenclatural changes:
Mettenia globosa (Sw.) Griseb. = **Chaetocarpus globosus** (Sw.) Fawc. et Rendle
Mettenia oblongata Alain in Contrib. Ocas. Mus. Hist. Nat. Col. de la Salle No. **11:** 10. 1952 = **Chaetocarpus globosus** ssp. **oblongatus** (Alain) Borhidi **comb.** et **stat. n.** — Syn.: *Mettenia globosa* ssp. *oblongata* (Alain) Borhidi in Botan. Közlem. **62:** 25. 1975.

Mettenia humilis Ekm. in Urb. Sertum Antillanum XXX. Feddes Repert. **28:** 229. 1930 = **Chaetocarpus humilis** (Ekm. in Urb.) Borhidi **comb. n.**
Mettenia cordifolia Urb. in Symb. Ant. **9:** 213. 1924 = **Chaetocarpus cordifolius** (Urb.) Borhidi **comb. n.** [Syn.: *Mettenia globosa* ssp. *cordifolia* (Urb.) Borhidi Botan. Közlem. **62:** 25. 1975].
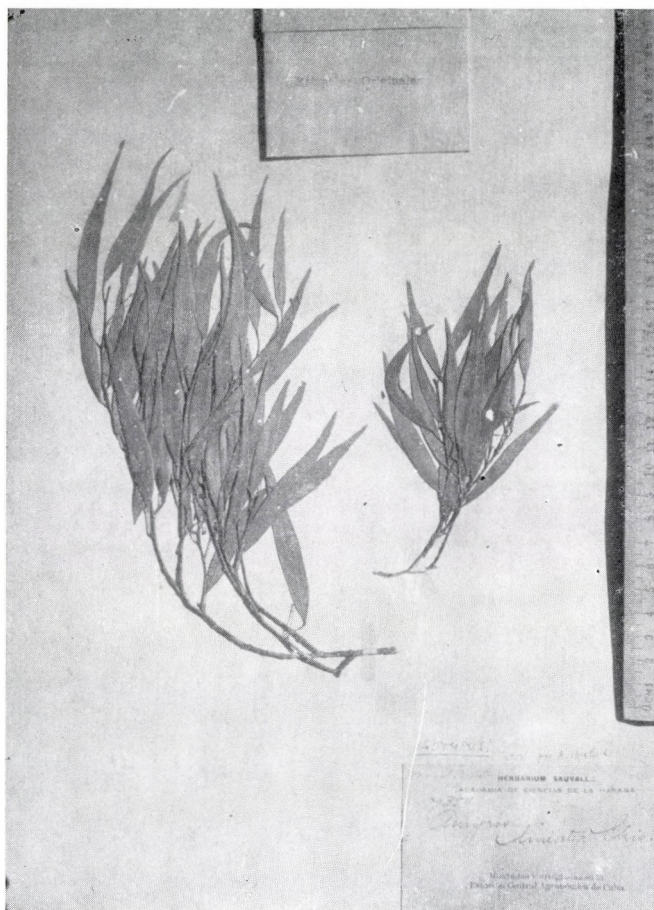
Fig. 13. Isotype specimen of *Amyris lineata* Griseb. (WRIGHT 1154 in Herb. Sauvalle HAC)

Mettenia acutifolia Britt. et Wils. in Bull. Torrey Bot. Club **39:** 9. 1912 = **Chaetocarpus acutifolius** (Britt. et Wils.) Borhidi **comb. n.**

Sapindaceae

A new critical taxonomic revision of the Cuban taxa of *Sapindaceae* is in preparation by H. LIPPOLD, who published a series of papers on the new results of his studies. The most important changes are as follows:

Serjania

Serjania albopunctata Wr. in Griseb. is a good endemic species of the Pinar del Rio Province according to LIPPOLD in Beiträge zur Phytotaxonomie 6. Folge p. 129. 1978, and

it is not identical with S. *subdentata* Juss., as it was reported (LEÓN and ALAIN: Flora de Cuba **3**: 188).

Serjania angusta Lippold Feddes Report. **85**: 612. 1974. Endemic to W-Cuba (Pan de Guajaibón, Sierra de Escambray).
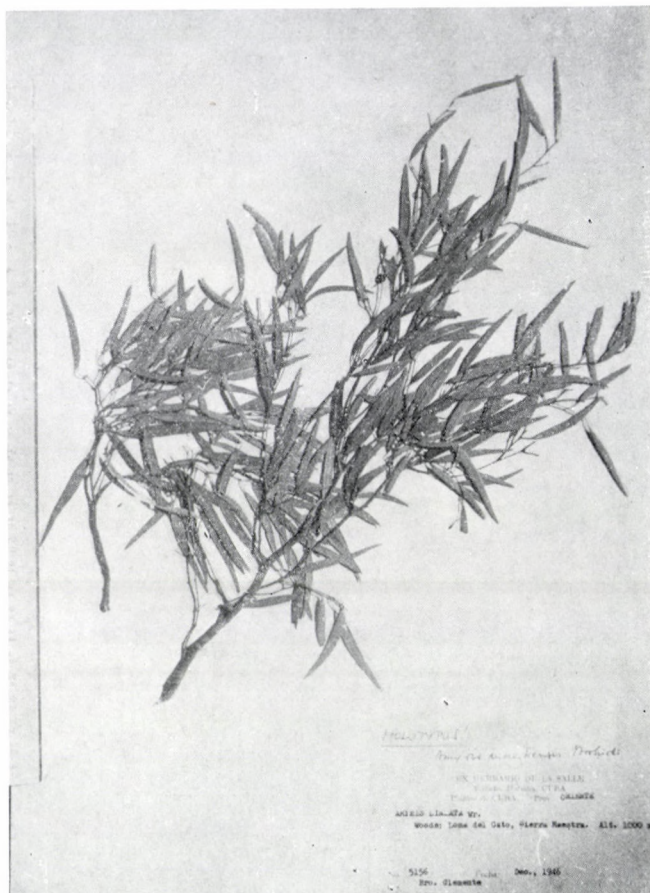
Fig. 14. Holotype specimen of *Amyris maestrensis* Borhidi et Kereszty (CLEMENTE 5156 HAC)

Serjania occidentalis Lippold l.c. p. 615. Endemic to the Peninsule of Guanahacabibes (Pinar del Rio Province).

Serjania linearifolia Lippold l.c. p. 612. Endemic to the SW-coast of the Sierra Maestra-Range between Cabo Cruz and Pilón (Oriente Province).

Serjania microphylla Lippold l.c. p. 615. Endemic to the south-eastern coastal region of the Province Oriente from Guantánamo to Maisi.

Allophylus

Allophylus occidentalis (Sw.) Radlk. = Allophylus racemosus Sw.

Allophylus roigii Lippold in Wiss. Zschr. Univ. Jena Math-Naturw. Reihe **19**: 383. 1970. Endemic to the Peninsule of Guanahacabibes and the southern part of the Isle of Pines.

Allophylus cristalensis Lippold (*A. reticulatus* Radlk. sensu León and Alain p.p.) in Feddes Repert **85**: 615. Endemic to the Nipe and Cristal Ranges of the northern part of Oriente Province.

Fig. 15. Holotype specimen of *Amyris verrucosa* Borhidi et Kereszty (Jack 7893 HAC)

Allophylus maestrensis Lippold l.c. p. 618. Endemic to the Sierra Maestra Range.

Allophylus crassinervis Radlk. is an endemic species of Puerto Rico and does not occur in Cuba, according to Lippold in Beitr. zur Phytotaxonomy **6**: 133.

Thouinia

Thouinia acunae Borhidi et Muñiz in Acta Bot. Acad. Sci. Hung. 21: 222. 1975. (*T. cubensis* Radlk. sensu León and Alain p.p.) Endemic to the limestone cliffs of the Nipe and Maestra Ranges (Prov. Oriente).

Thouinia baracoënsis Borhidi in Acta Bot. Acad. Sci. Hung. **22:** 309. (*T. cubensis* Radlk. sensu León and Alain in Flora de Cuba **3:** 197. 1953 p.p.) Endemic to the limestone haystack hill area at the gorge of Yumuri River, East of Baracoa (Prov. Oriente).

Thouinia clarensis Lippold in Feddes Repert **85:** 620. 1974. (*T. trifoliata* Poit. sensu León and Alain l.c. p. 196. p.p.) Endemic to the Sierra de Escambray, in Middle Cuba.

Thouinia holguinensis Lippold l.c. p. 621. (*T. trifoliata* Poit. sensu León and Alain p.p.) Endemic to the northern ciastal regions and keys of the provinces Camagüey and Oriente.

Thouinia hypoleuca Borhidi l.c. p. 309. = *T. canescens* Radlk. according to Lippold (in litt.)

Thouinia maestrensis Lippold l.c. p. 621. (*T. trifoliata* Poit. sensu León and Alain p.p.) Endemic to the western part of the Maestra Range between Cabo Cruz and Uvero.

Thouinia nervosa (A. Rich.) Griseb. (*T. trifoliata* Poit. sensu León and Alain p. maj. p.) is a valid endemic species of West-Cuba; it grows on the haystack hills and limestone coastal dog-tooth areas in the provinces Pinar del Rio, Habana and Matanzas, according to Lippold (1978: 135).

Thouinia pseudopunctata Lippold in Feddes Repert. **85:** 623. 1974. (*T. elliptica* Radlk. sensu León and Alain p.p. in Flora de Cuba **3:** 195. 1953. — *T. elliptica* var. *rotundata* Borhidi et Muñiz Acta Bot. Acad. Sci. Hung. **17:** 33. 1971.) Endemic to the southern coastal region of the Province Oriente between Santiago de Cuba and Maisi.

Dodonaea Miller in Cuba.

An excellent revision of this genus made by H. Lippold (Beitr. zur Phytotaxonomie 6. Folge 79—126, 1978) seems to give a good solution of the taxonomic problems concerning the American taxa of this highly polymorphic genus. According to Lippold (l.c.) the following species are represented in Cuba:

Dodonaea bialata H. B. K. (*D. viscosa* auct. amer. non L.). A species of neotropic distribution. It occurs in the Bermudas Florida, Greater Antilles, Mexico, Central and South-America to Brasil; in Cuba it can be found in all the provinces.

Dodonaea elaeagnoides Rudolphi ex Ledeb. et Adlerst. 1805. (*D. jamaicensis* Spreng. non DC., *D. ehrenbergii* Schlecht., *D. viscosa* var. *arborescens* (Cunn./Sherff) a species of Antillen distribution. It grows in Florida, Florida Keys, Bahamas, Greater and Lesser Antilles. In Cuba it occurs in the provinces Camagüey, Oriente and Isle of Pines.

Dodonaea linearifolia Linden ex Turcz. 1858. (*D. viscosa* var. *linearis* (Herv. et Sond./ Sherff f. *linearis* Sherff) Endemic to Cuba.

Dodonaea viscosa (L.) Jacq. s. str. A species of east-neotropic distribution. It occurs in Florida, Bahamas, Greater and Lesser Antilles and the eastern coastal region of South America. In Cuba it can be found in the Province Oriente and in Isle of Pines.

Cupania macrophylla A. Rich. non Mart. = Cupania cubensis G. Maza et Molinet. — A species of West-Caribbean distribution. It occurs in Mexico, Guatemala and Cuba, according to Lippold (l.c.).

Matayba oppositifolia (A. Rich.) Britton (*M. apetala* Alain in Suppl. Flora de Cuba 1969: 103, non Macfad.) A species of Cuba and Puerto Rico.

Sapindus grandifolius Lippold in Feddes Repert. **85:** 628. 1974. Endemic to East-Cuba at Maisi.

Celastraceae

Torralbasia domingensis Urb. is a good species living in Hispaniola and Cuba (Prov. of Oriente: Sierra Maestra; Prov. of Las Villas: Sierra de Escambray) according to Borhidi in Acta Agron. Acad. Sci. Hung. **27:** 433. 1978, where an analytic key for the taxonomic range of the genus *Torralbasia* is also done.

Sabiaceae

Meliosma herbertii Rolfe; Cuba; Prov. of Oriente, Yunque de Baracoa, 27391 HAC(SV); leg.: Del-Risco. New to Cuba.

Malvaceae

Malvastrum spicatum (L.) A. Gray = **Malvastrum americanum** (L.) Torr.
Abutilon giganteum (Jacq.) Sweet = **Abutilon elatum** (Macf.) Griseb.

Theaceae

Ternstroemia L. f.

Borhidi found the concept of *Ternstroemia peduncularis* León and Alain in Flora de Cuba **3**: 304. not DC. as a collective species in extremely amplified level, based on Kobuski's study (1943). In order to classify correctly the Cuban materials of the genus *Ternstroemia* we intended for elaborating a new analytic key as follows:

1 a Ovary generally unilocular; one of the bracteoles in 2 mm distance beneath the calyx (Cuba: Provinces of Pinar del Rio, Matanzas, Las Villas, Oriente; endemic) .... 1. **T. parviflora** Krug et Urb.
b Ovary bilocular, bracteoles next to the calyx 2
2 a Peduncles up to 1.5 cm long 3
b Peduncles longer than 1.5 cm 6
3 a Peduncles curved or reflexed 4
b Peduncles straight 5
4 a Leaves spathulate-oblong to oblong-elliptic, 6—11 cm long, blackish when dry, petiole 5—15 mm long (Cuba: Prov. of Pinar del Rio: Sierra de los Organos, Sierra del Rosario; endemic) .... 2. **T. cernua** Griseb.
b Leaves obovate, 2.5—5 cm long, reddish when dry, petiole 2—3 mm long (Cuba: Prov. of Oriente: Sierra Maestra, Pico Turquino, endemic) .... 3. **T. leonis** (Britt. et Wils.) Ekm. in Schmidt
5 a Leaves broadly elliptic, obovate or suborbicular, 3—5 cm long, rounded at the apex; peduncle 5—6 mm long; inner sepals 4—5 mm (Cuba; Prov. of Oriente: Baracoa endemic) .... 4. **T. baracoensis** O. C. Schmidt
b Leaves elliptic-ovate or oblong-elliptic, 4.5—7.5 cm long, obtuse to obtuse-acuminate at the apex; peduncle 10—15 mm long, inner sepals 3 mm (Cuba; Prov. of Oriente: Sierra Maestra, endemic) .... 5. **T. microcalyx** Krug et Urb.
6 a Leaves 2—5 cm long, fruit mostly conic 7
b Leaves 3.5—12 cm long, fruit mostly globose or ovate 9
7 a Midrib impressed beneath, leaf margin plane, generally glandular-denticulate towards the apex (Cuba; Prov. of Oriente; Sierra de Nipe, Sierra de Cristal, endemic) .... 6. **T. apleura** Krug et Urb.
b Midrib prominent beneath, leaf margin entire, revolute 8

8 a Leaves obovate-elliptic to suborbicular, blackish when dry, pale green beneath; peduncle straight, mostly erect, fruit long acuminate, acute at the apex (Cuba; Prov. of Oriente: Sierra Maestra, endemic) .... 7. **T. monticola** (Britt. et Wils.) Ekm. in Schmidt

b Leaves oblong-obovate, yellowish or reddish beneath when dray, peduncle curved or deflexed, generally ferrugineous pulverulent; fruit shortly conic, ovate, acute at the apex (Cuba; North of Oriente, endemic) .... 8. **T. flavescens** Griseb.

9 a Leaves elliptic to obovate, 4—12 cm long, thick coriaceous, reddish when dry, lateral veins prominent and mostly anastomosing on both surfaces, margin revolute; ovules 3—6 in each cavity (Cuba; Prov. of Oriente: Sierra de Moa, Sierra del Cristal, endemic) .... 9. **T. moaensis** Borhidi et Muñiz

b Leaves obovate, 3.5—8 cm long, mostly subcoriaceous, lateral veins obsolete or inconspicuous on both surfaces, non anastomosing; margin generally plane, ovules 5—15 in each cavity (Cuba, Hispaniola) .... 10. **T. peduncularis** DC. ssp. **obovalis** (A. Rich.) Borhidi

T. peduncularis ssp. *peduncularis*: Leaves ± granular-punctate, lateral veins conspicuous, margin curvate or broadly revolute, prophylla triangular-oblong or oblong-lanceolate, ovules 12—20 in each cavity (Puerto Rico to Trinidad).

T. peduncularis ssp. **obovalis** (A. Rich.) Borhidi **comb.** et **stat. n.** (Basionymon: *Ternstroemia obovalis* A. Rich. in Ramón de la Sagra: Hist. Fis. Pol. Nat. de la Isla de Cuba vol. X. p. 89. tab. 25.) Leaves not granular-pointed, lateral veins mostly obsolete or inconspicuous, margin plane or narrowly recurvate; prophylla semiorbicular or ovate; ovules 5—15 in each cavity (Cuba, Hispaniola).

Clusiaceae

Rheedia L.

Two analytic keys were published recently for the Cuban species; one for tree shaped *Rheedias* based exclusively on vegetative chatacters (Bisse in Ciencias Univ. Habana ser. 10. Botánica No. **2:** 15. 1975), the other for all the Cuban taxa by Borhidi (in Acta Bot. Acad. Sci. Hung. **22:** 311—312. 1976). According to these works the following changes are worth to mention:

Rheedia ruscifolia auct. Cub. non Griseb. for the specimens of the Moa-Baracoa region = **Rheedia moaensis** Bisse

Rheedia fruticosa Wr. ex Griseb. is an endemic species of the serpentine scrubs of the Province Pinar del Rio.

Rheedia fruticosa auct. Fl. Cub. non Wr. ex Griseb. p. p. as for the plants of the provinces Habana, Matanzas and Las Villas = **Rheedia cubensis** Borhidi

Rheedia fruticosa auct. Fl. Cub. non Wr. ex Griseb. as for the plants of the Province of Oriente, fig. 139. Flora de Cuba III. p. 311 = **Rheedia ophiticola** Borhidi

Flacourtiaceae

Banara riscoi Borhidi et Muñiz, Ciencias Biological Acad. Cien. Cuba **1:** 140. 1977. Holotype: HAC 27216 (SV), Cuba; Isle of Pine: Cayo Piedra; collected by E. Del-Risco; 8. Dec. 1970. Isotype: HAC.

Banara acunae Borhidi et Muñiz l.c. p. 141. Holotype: ACUÑA 10749 HAC; Cuba; Prov. Pinar del Rio; Sierra de los Organos, limestone scrub-forest of haystack-hill Loma Pendejeral, San Diego de los Baños. Isotype: HAC.
Xylosma roigiana Borhidi in BORHIDI et MUÑIZ l.c. p. 143. Fig. 16. Holotype: ROIG 5092
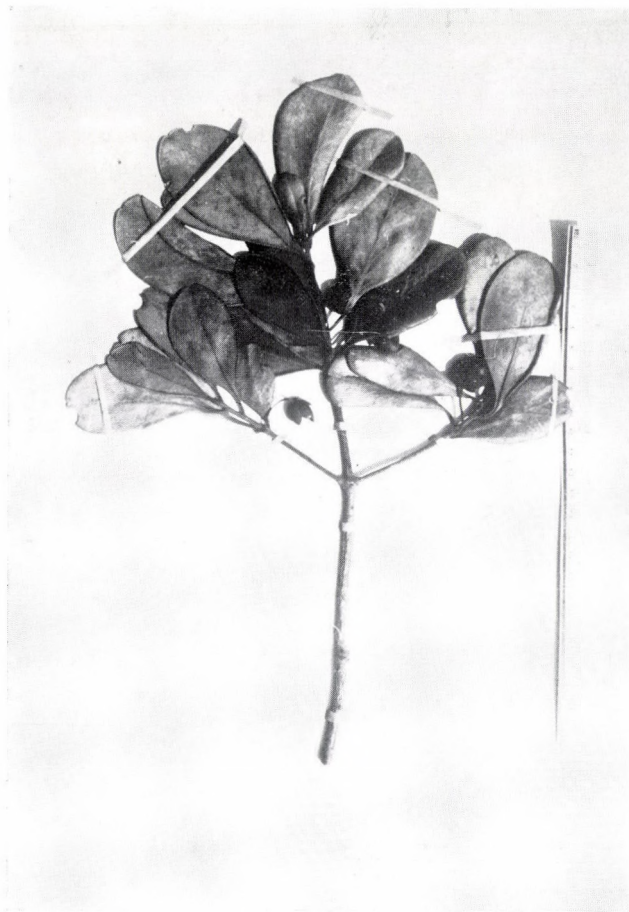
Fig. 16. Ternstroemia moaensis Borhidi et Muñiz, holotype specimen (BORHIDI, CAPOTE and OVIEDO 27821 HAC)

(CURBELO 57) HAC; Prov. Oriente; El Cupey, Puerto Padre; collected by M. CURBELO 7. May, 1930 with male flowers. Paratype: 5092/B HAC, with female flowers. (Fig. 17.)
Xylosma buxifolium A. Gray in Griseb. var. *rotundatum* Borhidi l.c. p. 144. Holotype: HAC 26031 Cuba; Prov. Oriente, Moa region; Nature Conserv. Area of Cupeyal del Norte. Collected by S. GANCHEFF, March, 1966.
Xylosma buxifolium A. Gray in Griseb. var. *cristalense* Borhidi l.c. p. 144. Holotype: ALAIN 5674 HAC Cuba; Sierra del Cristal near the peak. Collected by ALAIN H. LIOGIER, ACUÑA and LÓPEZ FIGUEIRAS, 2—7. Apr. 1956. Isotypes HAC and HAJB.

Xylosma acunae Borhidi et Muñiz l.c. p. 144—145. Holotype: 27698 HAC; Prov. Villa Clara in dry evergreen serpentine scrub of Cerro Pelo Malo, near to Santa Clara. Collected by ALFONSO and ANGULO with male flowers. Paratype: HAC 27693 with female flowers. Isotypes: BP and in Herb. Univ. Santa Clara. (Fig. 18—19.)

Fig. 17. Holotype specimen of *Xylosma roigiana* Borhidi (ROIG 5092)

Samyda dodecandra Jacq. probably does not occur in Cuba.
Samyda dodecandra auct. Fl. Cub. non Jacq. p. p. fig. 153 in the Flora de Cuba **3:** 337. 1953 = **Samyda campanulata** Borhidi et Muñiz Acta Bot. Acad. Sci. Hung. **22:** 313. 1976. Southern coast of the Province Oriente.
Samyda dodecandra auct. Fl. Cub. non Jacq. p. p. as for the specimens of the Northern coasts of the Provinces Camagüey and Oriente = **Samyda subintegra** Borhidi et Muñiz l.c. p. 314.

Turneraceae

Adenoa Arbo is a new monotypic genus, endemic for the serpentine-leteritic areas of the Northern Oriente in Cuba, based on the species *Piriqueta cubensis* Britt. et Wils. according to ARBO in Hickenia **1** : 89; 1977
Piriqueta cubensis Britt. et Wils. = **Adenoa cubensis** (Britt. et Wils.) Arbo

Cactaceae

Rhipsalis cassutha Gaertn. = **Rhipsalis baccifera** (J. S. Mill.) Stearn
Lemairocereus hystrix (Haw.) Britt. et Rose = **Stenocereus hystrix** (Haw.) Buxb.

Fig. 18. Holotype specimen of *Xylosma acunae* Borhidi et Muñiz (27698 HAC)

Myrtaceae

Approximately 40 new species were described from Cuba during the last eight years and a great number of nomenclatural changes were suggested according to ALAIN H. LIOGIER (1971), BISSE (1976), BORHIDI and MUÑIZ (1977a, b).

Psidium navasense Britt. et Wils. = **Myrtus navasense** (Britt. et Wils.) Bisse
Psidium reversum Urb. = **Myrtus reversa** (Urb.) Bisse
Psidium calycolpoides Griseb. = **Myrtus calycolpoides** (Griseb.) Burr.
Psidium versicolor Urb. = **Myrtus calycolpoides** (Griseb.) Burr.
Psidium jackii Urb. = **Myrtus calycolpoides** ssp. **jackii** (Urb.) Borhidi
Psidium leiophloeum (Urb.) Urb. = **Myrtus leiophloea** (Urb.) Bisse
Psidium claraense Urb. = **Myrtus claraensis** (Urb.) Bisse

Psidium araneosum Urb. = **Myrtus araneosa** (Urb.) Bisse
Psidium bullatum Britt. et Wils. = **Myrtus anomala** Burret
Psidium crenulatum Urb. et Ekm. = **Myrtus crenulata** (Urb. et Ekm.) Bisse
Psidium munizianum Borhidi in Acta Bot. Acad. Sci. Hung. **21:** 225. 1975 = **Myrtus muniziana** (Borhidi) Borhidi **comb. n.**

Fig. 19. Paratype specimen (with female flowers) of *Xylosma acunae* Borhidi et Muñiz (27693 HAC)

Amomis pilotoana Urb. = **Krokia pilotoana** (Urb.) Borhidi in Botan. Közlem. **64:** 213. 1977.
Pimenta moaensis Borhidi et Muñiz = **Krokia leonis** Borhidi et Muñiz **nom. nov.** non *Myrtekmania moaensis* Areces
Myrtekmania podocarpoides Areces in Ciencias Univ. Habana ser. 10. Botánica No. **3:** 4. 1975 = **Krokia podocarpoides** (Areces) Borhidi et Muñiz l.c. 213.
Amomis odiolens Urb. = **Krokia odiolens** (Urb.) Borhidi et Muñiz
Myrtekmania adenoclada (Urb.) Urb. = **Krokia adenoclada** (Urb.) Borhidi et Muñiz
Myrtus oligantha Urb. = **Krokia oligantha** (Urb.) Borhidi et Muñiz
Myrtekmania filipes Urb. = **Krokia filipes** (Urb.) Borhidi et Muñiz
Myrtekmania moaensis Areces = **Krokia moaensis** (Areces) Borhidi et Muñiz l.c. 214.

Melastomataceae

Graffenrieda cordifolia Alain = **Miconia cordifolia** (Alain) Borhidi in Abstracta Botanica Univ. Sci. Eötvös **5:** 32. 1977.
Miconia monocephala Urb. = **Pachyanthus monocephalus** (Urb.) Borhidi l.c. p. 27.
Miconia cuabae Urb. = **Henriettea cuabae** Borhidi l.c. 32. (Syn.: *Henriettella cuabae* Bisse)
Miconia urceolata Urb. = **Tetrazygia urceolata** (Urb.) Borhidi in Acta Bot. Acad. Sci. Hung. **23:** 37. 1977.
Miconia delicatula A. Rich. = **Tetrazygia delicatula** (A. Rich.) Borhidi l.c. 37.
Tetrazygiopsis Borhidi

A new genus was separated from *Tetrazygia* L. C. Rich. by the name of *Tetrazygiopsis* with 8 species of Antillean distribution (in Acta Bot. Acad. Sci. Hung. **23:** 34—35. 1977). The following nomenclatural changes were made:

Tetrazygia brachycentra Triana = **Tetrazygiopsis brachycentra** (Griseb.) Borhidi
Tetrazygia ekmanii Urb. = **Tetrazygiopsis ekmanii** (Urb.) Borhidi
Tetrazygia laxiflora Naud. = **Tetrazygiopsis laxiflora** (Naud.) Borhidi
Tetrazygia hispida (Sw.) Macf. = **Tetrazygiopsis hispida** (Sw.) Borhidi
Tetrazygia crotonifolia (Desr.) DC. = **Tetrazygiopsis crotonifolia** (Desr.) Borhidi
Tetrazygia biflora (Cogn.) Urb. = **Tetrazygiopsis biflora** (Cogn.) Borhidi
Tetrazygia tuerckheimii (Cogn.) Ekm. ex Urb. = **Tetrazygiopsis tuerckheimii** (Cogn.) Borhidi
Tetrazygia urbaniana (Cogn.) Croiz. = **Tetrazygiopsis urbaniana** (Cogn.) Borhidi
Tetrazygia minor Urb. = **Tetrazygia lanceolata** Urb. ssp. **minor** (Urb.) Borhidi
Miconia acunae Borhidi in Abstracta Botanica Univ. Sci. Eötvös Budapest **5:** 23. 1977. Holotype: 27223 HAC; Sierra Maestra, Alto de la Francia, Uvero; collected by L. STUCHLICK and M. MONCADA 8. Febr. 1971. Isotypes: HAC, BP.
Calycogonium rubens Borhidi l.c. 24. Holotype: UO 179 HAC; Sierra del Cristal, Rio Lebisa in alt. approx. 600 m.a.s.l. Collected by M. LÓPEZ FIGUEIRAS, 26. Aug. 1959. Isotypes: HAJB, BP.
Calycogonium floribundum Borhidi l.c. 25. Holotype: 26908 HAC; Sierra del Cristal. Collected by the German Mission for Investigations of Alcaloids. May, 1968.
Pachyanthus moaensis Borhidi l.c. 26. Holotype: 27745 HAC; (BORHIDI 4872) Prov. of Oriente; Sierra de Iberia, Taco Bay, in pine-woodland, Santamaria. Collected by BORHIDI, MUÑIZ and VAZQUEZ 22. March, 1970. Isotype: BP.
Pachyanthus acunaeanus Borhidi l.c. 27. Holotype: ALAIN 4259 HAC. Prov. of Pinar del Rio; Sierra de los Organos, Finca del Ancón, Viñales, in humid pine-woodland. Collected by ALAIN H. LIOGIER 19. May, 1955. It can be found in the Rosario-range as well.
Pachyanthus neglectus Borhidi l.c. 28. Holotype: 27746 HAC; Prov. of Oriente; in evergreen serpentine scrub of Mt. Cerro de Miraflores, Moa. Collected by BORHIDI, R. CAPOTE and R. OVIEDO 11. Sept. 1974. Isotypes: 27747 HAC, and BP.
— — ssp. *baracoënsis* Borhidi l.c. 29. Holotype: LEÓN 18390 HAC; Prov. de Oriente, Cuesta de Piedra, Baracoa. Collected by LEÓN 23. July, 1938.
Ossaea munizii Borhidi l.c. 30. Holotype: 27748 HAC (BORHIDI 3361); Prov. of Oriente; in the Nature Conserv. Area of Cupeyal, North of Guantánamo, in alt. approx. 850 m.a.s.l. Collected by BORHIDI, MUÑIZ and VAZQUEZ 9. Febr. 1970. Isotypes: 27749 HAC and BP.
Ossaea anomala Borhidi l.c. 31. Holotype: ALAIN 4906 HAC; Sierra de Nipe; Shady limestone cliffs; Loma Maceo, Cayo Rey. Collected by ALAIN H. LIOGIER, C. V. MORTON and LÓPEZ FIGUEIRAS 7. January 1956.
Heterotrichum octonum (Bonpl.) DC. = **Clidemia octona** (Bonpl.) L. O. Williams

Myrsinaceae

The genus *Rapanea* was included into the *Myrsine* L. by W. T. STEARN in Bull. Brit. Mus. Nat.-Hist. Bot. **4:** 174. 1969 followed by a number of nomenclatural changes:
Rapanea ferruginea (Ruiz et Pav.) Mez = **Myrsine coriacea** (Sw.) R. Br. ex Roem. et Schult.
Rapanea guianensis auct. Fl. Cub. non Aubl. = **Myrsine cubana** A. DC. according to BORHIDI in Acta Agron. Acad. Sci. Hung. **27:** 437. 1978.
Rapanea microphylla Britt. et Wils. = **Myrsine microphylla** (Britt. et Wils.) Alain

Theophrastaceae

Jacquinia L.

A revision of the Cuban species was published in Plant Syst. Evol. **129:** 1—11. 1978 by BORHIDI and MUÑIZ with a new analytic key and descriptions of 5 new species: *J. maisiana*, *J. oligantha*, *J. moana*, *J. stenophylloides* and *J. nipensis*, and with distribution maps of the species.

Onagraceae

Ludwigia microcarpa Fawc. et Rendle non Michx. = **Ludwigia simpsonii** Chapm.

Menyanthaceae

Nymphoides humboldtiana (Kunth) Kuntze = **Nymphoides indica** (L.) Kuntze

Convolvulaceae

Ipomoea pes-caprae (L.) R. Br. ssp. *brasiliensis* (L.) Ooststr. is the vicariant neotropical subspecies existing also in Cuba.

Borraginaceae

Tournefortia gnaphalodes L. = **Mallotonia gnaphalodes** (L.) Britt.
Cordia stenophylla Alain p.p. = **Cordia suffruticosa** Borhidi in Acta Bot. Acad. Sci. Hung. **22:** 315. 1976.
Cordia cinerascens A. DC. p.p. = **Cordia holguinensis** Borhidi et Muñiz l.c. 316.

Verbenaceae

Phyla betulifolia (HBK.) Greene = **Lippia betulifolia** Kunth
Phyla scaberrima (A. L. Juss.) Mold. = **Lippia scaberrima** (A. L. Juss.) Sond.
Phyla stoechadifolia (L.) Small = **Lippia stoechadifolia** (L.) Kunth
Phyla nodiflora (L.) Greene = **Lippia nodiflora** (L.) Michx.
Phyla strigulosa (Mart. et Gal.) Mold. = **Lippia strigulosa** Mart. et Gal.
Pseudocarpidium wrightii Millsp. = **Pseudocarpidium ilicifolium** (A. Rich.) Millsp. sensu A. Rich.
Pseudocarpidium ilicifolium (A. Rich.) Millsp. sensu Millsp. = **Pseudocarpidium neglectum** Bisse in Ciencias Univ. Habana ser. 10. Botanica No. 2: 19. 1975 sub nomine *Pseudocarpidium "neglecta"*.
Vitex tomentosula Mold. p.p. as for the plants of the Province Pinar del Rio = **Vitex guanahacabibensis** Borhidi and **Vitex acunae** Borhidi et Muñiz in Acta Bot. Acad. Sci. Hung. **22:** 317—318. 1976.

Solanaceae

Solanum aculeatum (Jacq.) O. E. Schulz = **Solanum aquartia** Dunal

— *Scrophulariaceae*

Scrophularia micrantha Desr. = **Scrophularia minutiflora** Pennell
Gerardia albida (Britt. et Penn.) Penn. = **Agalinis albida** Britt. et Penn.
Gerardia linifolia Nutt. = **Agalinis linifolia** (Nutt.) Britt.
Gerardia purpurea L. = **Agalinis purpurea** (L.) Penn.

Bignoniaceae

Schlegelia brachyantha Griseb. = **Schlegelia parasitica** (Sw.) Miers ex Griseb.
Spirotecoma apiculata (Britt.) Alain p.p. = **Spirotecoma guantanamensis** Bisse in Ciencias Univ. Habana ser. 10. Bot. No. 2: 20. 1975.
Catalpa punctata Griseb. var. *pubescens* Griseb. = **Catalpa pubescens** (Griseb.) Bisse l.c. 21. Southern Oriente.

Acanthaceae

Blechum brownei Juss. = **Blechum pyramidatum** (Lam.) Urb.
Anthacanthus Nees 1847 = **Oplonia** Raf. 1838 according to the excellent monograph of T. W. Stearn (Bull. Brit. Mus. Nat.-Hist **4.** No. 7. 259—323. 1971). The above results and a recently published other revision of this genus (Borhidi and Muñiz in Acta Bot. Acad. Sci. Hung. **23:** 303—317. 1977) modified the number and names of the Antillean species, as follows:
Psilanthele jamaicensis Lindau = **Oplonia jamaicensis** (Lindau) Stearn
Anthacanthus armatus (Sw.) Nees = **Oplonia armata** (Sw.) Stearn
Anthacanthus acicularis sensu Lindau in Urb. p.p. = **Oplonia armata** var. **pallidior** Stearn
Oplonia moana Borhidi in Borhidi et Muñiz l.c. 308. (Cuba: Moa region, endemic)
Anthacanthus spinosus (Jacq.) Nees = **Oplonia spinosa** (Jacq.) Raf. sensu Borhidi non Stearn 1971 divided into 2 subspecies:
— — ssp. *spinosus* (Hispaniola—Virgin Islands)
— — ssp. *insularis* Borhidi l.c. 308. (Bahamas)
Anthacanthus spinosus auct. Fl. Cub. = **Oplonia cubensis** Borhidi l.c. 309.
Anthacanthus nannophyllus Urb. = **Oplonia nannophylla** (Urb.) Stearn
Anthacanthus purpurescens Griseb. = **Oplonia purpurascens** (Griseb.) Stearn
Oplonia multigemma Borhidi l.c. 312. (Cuba: serpentine barrens of Holguin, Prov. of Oriente; syn.: *Oplonia tetrasticha* var. *polyece* Stearn p.p.)
Anthacanthus microphyllus (Lam.) Nees = **Oplonia microphylla** (Lam.) Stearn
Anthacanthus acicularis (Sw.) Nees = **Oplonia acicularis** (Sw.) Stearn
Anthacanthus tetrastichus Wr. ex Griseb. = **Oplonia tetrasticha** (Wr. ex Griseb) Stearn sensu Borhidi l.c. 309—310.
Oplonia polyece (Stearn) Borhidi l.c. 312—313. Coastal regions of the Province of Oriente; Cuba; endemic. (Basionymon: *Oplonia tetrasticha* var. *polyece* Stearn p.maj.p. l.c. 311.)
Oplonia acunae Borhidi l.c. 313. (Cuba: Sierra Maestra, endemic)
Elytraria planifolia Leonard is divided into 2 subspecies:
— — ssp. *planifolia* and
— — ssp. *acunae* Borhidi et Muñiz l.c. 315.
Two other new species of the genus *Elytraria* are also published: *E. spathulifolia* Borhidi et Muñiz l.c. 315. and *E. filicaulis* Borhidi et Muñiz l.c. 315—316.

Gesneriaceae

Pheidonocarpa L. Skog 1976

The recently created new genus for the species of Cuba and Jamaica formerly classified in *Heppiella* seems to be an adequate solution of this taxonomic problem, and the new genus *Pheidonocarpa* can be accepted. At the same time we can not agree with the subspecific status of the Jamaican and Cuban taxa, respectively. As for the morphology, both taxa have well defined morphologically rather constant, populations variable at very low level without any morphological transition or intermediate forms. The habitats of the two following taxa are not as similar as L. SKOG wrote, because *Pheidonocarpa corymbosa* (Sw.) Skog grows on shaded limestone cliffs, while *Ph. cubensis* (Morton) Borhidi lives in an extremely dry semidesertic limestone-area, on sunny cliffs and slopes. The areas of the two taxa had been geographically isolated more than 1 million years ago, and there is no evidence of any genetic interaction between the Cuban and Jamaican populations. For this reason I prefer to consider them as two different species:

Pheidonocarpa cubensis (Morton) Borhidi **comb. n.**

Basionymon: *Heppiella cubensis* Morton in Brittonia **9:** 21. 1957. [Syn.: *Gesneria mortonii* Wiehler in Baileya **18:** 4. 1971. — *Pheidonocarpa corymbosa* (Sw.) Skog. ssp. *cubensis* (Morton) Skog. in Smiths. Contrib. to Bot. **29:** 43. 1976.]

Some remarks on Cuban resp. Antillean Gesnerias

A very considerable monograph was published by L. SKOG (1976) on the Tribe *Gesnerieae* with a critical revision of the genus Gesneria (Smithsonian Contributions to Botany No. 29. 1976). This revision was based on field and herbarium studies, but the author had no opportunity to acquire field experience in Eastern Cuba and Haiti, although these areas must be considered as evolutionary centers of the Antillean Flora including the genus *Gesneria*. In spite of this, the author realized a valuable, polyfacetic and fundamental work, first of all, in respect of the superspecific level of the genus dividing it into 9 sections. Regarding the details of his taxonomic study, I have to make some remarks, as follows:

General remarks

1. *Reduction of taxa:* The former monographers of the *Gesneriaceae*, as URBAN and MORTON were outstanding botanists and I have had innumerable opportunities during my taxonomic activity to prove that the taxa described

by them were mostly really existing ones at some taxonomic rank. SKOG reduced to synonyma, without taxonomic rank, as many as 22 species described by URBAN (15 species), ALAIN (4), BRITTON and WILSON (2) and MORTON (1) not mentioning here a large number of reduced subspecific taxa. Reduction is an up to date trend in taxonomy, but it is sometimes forced, and helps more to occult the deficiency of the taxonomic studies than to achieve a comprehensive knowledge of the real variability and richness of nature.

2. *Species concept:* Distinction among the species was made by SKOG, first of all, upon a basis of herbarium morphological differences. Many authors think, that the scale or extent of morphological differences are the confidential criteria of taxonomic ranking, and consider populations with greater morphological distinction as species, other ones with less differences as subspecies, and other populations morphologically even less distinct, as varieties. This concept leads necessarily to a high number of subjective taxonomic decisions.

The species concept must be based on the discontinuity of variability ranges. "Big" and "little" morphological differences must be considered equally consequent and "good" specific features if they are separated by a morphological hiatus accompanied mostly by a genetic barrier between the different populations.

The high number of the endemic vicariant species is an important characteristic of the West Indian flora. Most of these endemic species are represented by few, little-membered populations inhabiting a small distributional area. Most of these endemic "little species" developed from one or more ancient species of the respective genera by the separation of the different islands, and by marine transgressions isolating them first geographically, and after the geographic isolation the few-membered populations have been divided morphologically and genetically as well by the genetic drift. At one hand, in the continents the mechanism of speciation by driftage of the little populations is rather rare and not efficient; — occurs mostly in the flora of the elevated peaks of mountains. On the other hand, in the special ecological conditions of the island ecosystems of higher specific adaptation and lower competition, genetic drift may be an important way in the evolution of the flora.

3. *Infraspecific ranks.* According to SKOG (1976: 39) "The criterion for distinguishing subspecies within the species has been the presence of morphological variants appearing in two or more geographically distinct populations. Some species of *Gesneria* have been divided into varieties because the plants are less morphologically distinct or geographically isolated than those taxa considered subspecies in other species". These criteria are unacceptable. The quantity of the existing populations cannot be considered as criterium of a taxonomic rank. Not referring here to the theoretical weakness of this concept, the flora of the West Indies is not well-known enough to permit us to determine exactly, how many of populations really exist in the different taxa. In the

Yunque de Baracoa of Cuba — one of the most important gene-centers of the *Gesnerias* — about ten different populations of *Gesneria purpurascens* are known. By a specialist who knows the material only from herbaria, all these populations may be considered as a single one. And this is an important starting-point of taxonomic mistakes, because leads to confusion in the inter-populational and infrapopulational variability. For this reason is that in the use of the variety rank a lot of inconsequences can be found. As for our concept, the populations of both subspecies and varieties differ mostly in quantitative characters and in the case of both can be found morphologically transitional populations between the typical populations and them (lack of hiatus !). The subspecies have a geographically or ecologically "independent" isolated or vicariant area, varieties have their populations within the distribution range of the typical taxon.

On the basis of the above criteria I suggest the following changes in the taxonomy of the genus *Gesneria*:

Gesneria verrucosa (Decne) O. Kuntze (Basionymon: *Pentaraphia verrucosa* Decaisne Ann. Sci. Nat. Bot. sér. 3; **6:** 107. 1846).

— — ssp. *verrucosa*

— var. *verrucosa*

— var. **cubensis** (Decne) Borhidi **comb.** et **satus novus**

(Basionymon: *Pentaraphia cubensis* Decaisne Ann. Sci. Nat. Bot. ser. 3; **6:** 108. 1846.)

— — ssp. **truncata** (Alain) Borhidi **comb.** et **status novus**

(Basionymon: *Gesneria truncata* Alain Brittonia **20:** 155. 1968. *Gesneria cubensis* **var.** *truncata* (Alain) Skog Smiths. Contr. 29: 57. 1976.]

Gesneria heterochroa Urb.

— var. *heterochroa*

— var. **turquinensis** (Morton) Borhidi **comb. nova**

(Basionymon: *Gesneria clarensis* Britt. et Wils. var. *turquinensis* Morton in Brittonia **9:** 19. 1957.)

Gesneria ferruginea (Wr. in Sauv.) Urb. is a valid serpentinicolous species, endemic to the Cajalbana-Range (Province of Pinar del Rio); morphologically, geographically and ecologically distinct and isolated completely from *G. salicifolia* (Griseb.) Urb.

Gesneria salicifolia (Griseb.) Urb.

— — ssp. *salicifolia*

— — ssp. **gibberosa** (Urb.) Borhidi **comb. nova**

(Basionymon: *Gesneria gibberosa* Urb. in Feddes Repert. **13:** 477. 1915.)

— — ssp. **spathulata** (L. Skog) Borhidi **status novus**

(Basionymon: *Gesneria salicifolia* var. *spathulata* L. Skog in Smiths. Contrib. to Botany **29:** 71. 1976.)

Gesneria scabra Sw.

— — ssp. *scabra*

— — ssp. **sphaerocarpa** (Urb.) Borhidi **status novus**

(Basionymon: *Gesneria sphaerocarpa* Urb. in Symb. Ant. **5:** 499. 1908. — Syn.: *Gesneria scabra* var. *sphaerocarpa* Skog l.c. 83.)

Gesneria fawcettii Urb.

— — ssp. *fawcettii*

— — ssp. **viridicalyx** (Skog) Borhidi **comb.** et **status novus**

Basionymon: *Gesneria scabra* var. *viridicalyx* Skog in Smiths. Contrib. to Botany **29:** 84. 1976.

Gesneria duchartreoides sensu L. Skog non (Wr. in Sauv.) Urb. is a collective species, artificially unified of five or at least four distinct species, by L. SKOG. This fact is evident for all botanists who have ever seen and collected in flower living specimens of *Gesneria nipensis* Britt. et Wils. (endemic to Nipe Mountains), *G. pachyclada* Urb. (endemic to Cristal Mountains), *G. norlindii* Urb. (endemic to the Moa-Toa-Ranges), *G. duchartreoides* (Wr. in Sauv.) Urb. and *G. bracteosa* Urban (endemics to Baracoa-Range). Within the strikingly wide variability range of *G. duchartreoides* interpreted by SKOG there cannot be found a continuity either in morphological or in a geographical respect. The Sectio *Myrmekianthe* Skog is represented really by four or five good species or at least by vicariant subspecies. The distribution map of this section published by SKOG (fig. 52, p. 89) is rather inaccurate, the author obviously had no knowledge about the geography of its distribution range, as it turns out from the numerous orthographic mistakes when describing the names of Cuban localities.

Gesneria humilis L.

— — ssp. *humilis*

— — ssp. **celsioides** (Griseb.) Borhidi **comb.** et **status novus**

[Basionymon: *Conradia celsioides* Griseb. in Cat. Plant. Cub. 200. 1866. — Syn.: *Pentaraphia celsioides* (Griseb.) Gómez de la Maza Anal. Soc. Esp. Hist. Nat. **23:** 279. 1894. — *Gesneria celsioides* (Griseb.) Urb. Symb. Ant. **2:** 377. 1901.]

SKOG supposed *G. celsioides* is nothing more than an ecological modification of *G. humilis* L. It is a mistake, because *G. celsioides* lives in several populations in the Organos-Range (Province of Pinar del Rio) growing on shady cliffs, rather far from river beds, habitat of *G. humilis*. *Gesneria humilis* L. is one of the few species in this genus without any special ecological demand, and grows on limestone, serpentine and volcanic rocks without any notable morphological modification, and this fact contradicts the theory of SKOG. Therefore, due to the mostly quantitative morphological differences between the two taxa I suggest considering them as subspecies.

Gesneria libanensis Linden ex Morren

— — ssp. *libanensis*

— — ssp. **lopezii** (Morton) Borhidi **comb.** et **status novus**

(Basionymon: *Gesneria lopezii* Morton in Brittonia **9:** 19. 1957.)

Gesneria purpurascens Urb.

— var. *purpurascens*

— var. **yumuriensis** (Britt. et Wils.) Borhidi **comb.** et **status novus**

(Basionymon: *Gesneria yumuriensis* Britt. et Wils. in Mem. Torr. Bot. Club **16:** 109. 1920 as "*G. yamuriensis*".)

Gesneria acunae Borhidi in Acta Bot. Acad. Sci. Hung. **22:** 320. 1976 (fig. 20) with calyx lobes 10—13 mm long, linear-lanceolate, corolla 25—28 mm long, tube obconic, not ventricose at the middle, 7—9 mm wide at the throat, with basal lobe 8—10 mm long and wide, capsule 5—6 mm long, villous, obviously does not belong to *G. purpurascens* Urb., as it was classified by SKOG (1976: 118) based on the holotype specimen (ALAIN and ACUÑA 7541).

Gesneria pallida Morton in Borhidi et Muñiz Acta Bot. Acad. Sci. Hung. **22:** 319. 1976 with 1—2 cm long peduncled 1-flowered inflorescences, calyx lobes lanceolate, 1-nerved, corolla pallid yellow (Type specimen: ALAIN 7609) does not belong to *G. reticulata* (Griseb.) Urb., as it was classified by SKOG (1976: 120).

Key to the species of the Section *Duchartrea*

1 a Calyx lobes thickened and hollow apically (Cuba, endemic) .... **Gesneria viridiflora**
— Leaves obtuse or emarginate at the apex, corolla green, lobes long fimbriate .... ssp. **viridiflora**
— Leaves acute, corolla red or reddish-yellow, lobes somewhat short fimbriate .... ssp. **colorata**
b Calyx lobes rounded to acuminate, not thickened and hollow apically 2
2 a Corolla verrucose, capsule grossely verrucose (South-Western Haiti, endemic) .... **Gesneria acrochordonanthe**
b Corolla smooth, capsule smooth to finely verrucose (Hispaniola, Puerto Rico) .... **Gesneria sintenisii**
— Leaves subcoriaceous, membranous when young, green beneath, upper corolla lobe entire (Porto Rico, endemic) .... ssp. **sintenisii**
— Leaves coriaceous, even when young, copper coloured beneath, upper corolla lobe denticulate (Santo Domingo, endemic) .... ssp. **quisqueyana**

Gesneria viridiflora (Decaisne) O. Kuntze
— — ssp. *viridiflora*
— — ssp. *colorata* (Morton) Borhidi
Gesneria acrochordonanthe (Skog) Borhidi **status novus**
(Basionymon: *Gesneria viridiflora* ssp. *acrochordonanthe* Skog Smiths. Contrib. to Botany **29:** 139. 1976.)
Gesneria sintenisii Urb.
— — ssp. *sintenisii*
— — ssp. **quisqueyana** (Alain) Borhidi **comb.** et **status novus**
[Basionymon: *Gesneria quisqueyana* Alain in Mem. New York Bot. Gard. **21** (2): 147. 1971. — Syn.: *Gesneria viridiflora* ssp. *quisqueyana* (Alain) Skog l.c. 140.]

Rubiaceae

Portlandia ophiticola Borhidi in Abstracta Bot. Univ. Sci. Eötvös Budapest **5:** 34. 1977. Holotype: UO 1037 in HAC; Cuba, Prov. Oriente, Sierra de Nipe, charrascal de La Cueva, Pinares de Mayari. Collected by López Figueiras 27—31, May, 1960. Isotypes: HAC, HAJB.
Portlandia acunae Borhidi l.c. 35. Holotype: Alain 7381 in HAC; Cuba; Prov. Oriente; Sierra de Nipe: on limestone cliffs of Florida Blanca, Alto Songo in alt. approx. 450 m.a.s.l. Collected by Alain, Acuña and López Figueiras. Isotypes: HAC.
Isidorea rheedioides Borhidi l.c. 37. Holotype: Alain 7097 in HAC; Cuba; Prov. Oriente; in limestone littoral thickets between Cajobabo and Jauco. Collected by Alain and López Figueiras, December 31, 1959.
Schmidtottia corymbosa Borhidi l.c. 37. Holotype: León 23224 HAC; Cuba; Prov. Oriente; Mina Franklyn in pine woodlands near to Moa. Collected by León and Clemente July 20, 1947. Isotype: Clemente 5543 HAC.
Schmidtottia stricta Borhidi l.c. 38. Holotype: 27797 HAC; Cuba; Prov. Oriente; in serpentine thickets of a valley in the Mount Cerro de Miraflores near to Yaguaneque, Moa. Collected by M. Moncada and A. Borhidi, September 11, 1974. Isotype: BP.

Fig. 20. Holotype specimen of *Gesneria acunae* Borhidi (ALAIN 7541)

Coccocypselum pseudotontanea Griseb. var. *glaberrima* Borhidi et Muñiz in Abstracta Bot. Univ. Sci. Eötvös Budapest **5:** 40. 1977. Holotype: LF 2270 HAC; Cuba; Prov. Oriente; Sierra Maestra; in montane rain forests of La Maestrica, Alto de Valenzuela in alt. 1300—1500 m.a.s.l. Collected by LÓPEZ FIGUEIRAS August 10, 1955. Isotypes: HAC, HAJB.

Coccocypselum oblongatum Urb. = **Coccocypselum × oblongatum** (Urb.) Borhidi et Muñiz [*C. pseudotontanea* var. *glaberrima* × *C. lanceolatum* (Ruiz et Pavon) Pers.]

Antirhea minutifolia Borhidi et Capote in Abstracta Bot. Univ. Sci. Eötvös, Budapest, **5:** 40. 1977. Holotype: 27803 HAC; Cuba; Prov. Oriente; in arid serpentine microphyllous thicket of Cerro Galano near to Holguin. Collected by BORHIDI, CAPOTE et OVIEDO, September 25, 1975. Isotypes: HAC, BP.

Antirhea nipensis Borhidi et Muñiz l.c. 41. Holotype: 27798 HAC; Cuba; Prov. Oriente; Sierra de Nipe; in pine woodland of Pinalito, South of Pinares de Mayari. Collected by J. REYES XLIV/31. March, 1975. Isotype: BP.

Machaonia urbinoi Borhidi et Muñiz l.c. 42. Holotype: 277. HAC; Cuba; Prov. Oriente; in serpentine thickets of the peak of Cerro Galano, near to Holguin. Collected by J. URBINO, August 14, 1975. Isotypes: HAC(SV); BP.

Casasia clusiifolia (Jacq.) Urb. var. *hirsuta* Borhidi l.c. 43. Holotype: 27768 HAC; Cuba; Prov. Oriente; in littoral limestone woodland between Gibara and Caletones. Collected by Borhidi, Capote and Oviedo, September 26, 1975. Isotypes: HAC; BP.
Richardia L. in Cuba.
An excellent taxonomic revision published by W. H. Lewis and R. L. Oliver (Brittonia *26.* 271—301. 1974) made necessary the following changes:
Richardia brasilensis Gómez = **Richardia scabra** L.
Diodia arenicola Britt. et Wils. = **Richardia arenicola** (Britt. et Wils.) Lewis et Oliver
Diodia ciliata Britt. et Wils. = **Richardia ciliata** (Britt. et Wils.) Lewis et Oliver
Diodia pectidifolia Urb. Symbolae Antillanae **9** : 540. 1928. = **Richardia pectidifolia** (Urb.) Borhidi **comb.** n. (*Richardia muricata ssp. pectidifolia* Lewis et Oliver)

Campanulaceae

Siphocampylus glaber McVaugh is a separate species. Wimmer doubted *S. glaber* could have blue corolla (after Shafer) being the only occurrence of this feature in the genus *Siphocampylus* and included *S. glaber* to *S. subglaber* Urb. as its variety. This decision was accepted by Alain H. Liogier in the Flora de Cuba **5:** 169. 1964 as well. Borhidi and Muñiz and their collaborators collected *S. glaber* several times in the Nipe Mountains and observed, this species has always corolla of blue tube and red lobes, features never observed in *S. subglaber* Urb. having corollas of red tube and yellow lobes. *S. glaber* is an endemic species to the Nipe and Cristal Ranges, while *S. subglaber* is endemic to the Moa-Toa-Baracoa Range.
Lobelia cacuminis Britt. et Wils. in Bull. Torr. Bot. Club **50:** 50. 1923 = **Lobelia oxyphylla** Urb. ssp. **cacuminis** (Britt. et Wils.) Borhidi **status novus.** — [Syn.: *L. oxyphylla* var. *cacuminis* (Britt. et Wils.) E. Wimmer in Pflanzereich **IV. 276/b** (107): 621. 1953.]
Lobelia oxyphylla Urb. sensu M. Vict. et sensu Alain p.p. = **Lobelia shaferi** Urb. with 3 varieties: var. *shaferi*, var. *obtusata* (Urb.) E. Wimm. and var. *nipensis* (Urb.) E. Wimm.

Compositae

Melanthera deltoidea Michx. = **Melanthera aspera** (Jacq.) L. C. Rich.
Ambrosia paniculata Michx. = **Ambrosia peruviana** Willd.
Xanthium chinense auct. antill. = **Xanthium occidentale** Bertol.
Emilia sagittata (Vahl) DC. = **Emilia javanica** (Burm. f.) Robins.
Pluchea purpurascens (Sw.) DC. = **Pluchea odorata** (L.) Cass.
Trixis radialis Kuntze = **Trixis inula** Crantz
Lactuca intybacea Nacq. = **Launaea intybacea** (Jacq.) Beauv.

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NOTAS SOBRE TÁXONES CRITICOS O NUEVOS DE LA FLORA DE CUBA

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The authors try to resolve some taxonomic problems of the Cuban Flora proposing some corrections, new combinations and describing 10 species, 3 varieties and 1 hybrid, all new to science. They discuss the problem of *Magnolia leonis* Tujan, ex Bisse and *M. cacuminicola* Bisse (*Magnoliaceae*), the differentiation of *Cissampelos Pareira* L. and *C. reticularis* sp. n. (*Menispermaceae*), the problem of distinction of *Pera longipes* Britt. et Wils. from *P. pallidifolia* Britt. et Wils. and that of *Pera ovalifolia* Urb. from *P. orientensis* sp. n. (*Euphorbiaceae*). The paper deals with the differences between *Purdiaea nipensis* M. Vict. and *P. maëstrensis* sp. n. (*Cyrillaceae*) and presents a new analytical key for 8 Cuban species of the genus *Linociera* (*Oleaceae*). Further new taxa are: *Pera polylepis* ssp. *moaënsis* (*Euphorbiaceae*), *Xylopia Acunae* (*Annonaceae*), *Ilex baracoënsis* and *I. hypaneura* var. *nudicalyx* (*Aquifoliaceae*), *Ouratea* × *Acunae* (*Ochnaceae*), *Linociera Acunae*, *L. Moncadae*, *L. bumelioides* ssp. *obovalis*, and *Forestiera Ekmanii* (*Oleaceae*), finally *Lantanopsis tomentosa* (*Compositae*).

Fam.: **Magnoliaceae**

Magnolia leonis Tujanitskaya ex Bisse nom. nud.

Este nombre específico fue publicado por J. BISSE (Feddes Repert. **85:** 587. 1974. dic. 20) y mencionado por HOWARD (Taxon 1976: 419.) en su articulo informativo sobre los resultados recientes de las investigaciones sobre la flora de Cuba, como un nombre dudoso. En realidad **Magnolia leonis** es un nombre desnudo (nomen nudum), que no ha sido publicado validamente por ningun autor. Por otra parte "Tujanitskaya" es probablemente un error tipográfico en lugar del apellido correcto del autor, que es: IMCHANITSKAYA, monografista sovietica de las magnoliáceas cubanas. El taxon cuestionado fue legitimamente descrito con prioridad, como *Magnolia cubensis* Urb. ssp. *Acunae* Imchanitskaya (Botan. Mater. Herbar. Inst. Komarov **35:** 144. 1974. jul. 15.), lo que nosotros consideramos como un rango taxonómico adecuado para las poblaciones de *Magnolia* existentes en la Sierra de Escambray (Prov. Las Villas). En consecuencia de esto *Magnolia cubensis* Urb. se divide en dos subespécies vicariantes de los cuales la ssp. cubensis vive en la Sierra Maestra (Prov. Oriente) y la ssp. *Acunae* en la Sierra de Escambray.

Magnolia cacuminicola Bisse

Este taxon fue descrito por primera vez como *Magnolia cubensis* Urb. var. *baracoënsis* Imchanitskaya (l.c. p. 146.) a base de los ejemplares colectados por BISSE en la Sierra de Imias (Prov. Oriente); sin embargo parece mas correcto considerarlo como espécie distinta de la *M. cubensis* Urb. Por esta razón el nombre específico *M. cacuminicola* Bisse debe considerarse válido.

Fam.: **Menispermaceae**

Cissampelos reticulata Borhidi sp. n.

Planta volubilis; caulis juvenilis sparse et tenuissime ferrugineo-pilosus, postremo glaber. Folia 1—1,5 cm longe petiolata, petiolis volubilibus, ferrugineo-hirsutis, suffulta, a basi 1—8 mm remote peltata, late vel oblongo-cordiformia, vel oblongo-ovata, antice attenuata et obtusa et mucronulata vel rotundato-truncata et emarginata, basi truncata vel profunde cordata, 2—6 cm longa et 2—3,5 cm lata, supra lucida essentialiter glabra, in sicco nigra, palmatinervia et densissime prominenter reticulata, subtus cinerea, opaca vel nitidula, densissime et prominenter reticulato-venosa, in nervis puberula, inter nervos glabra, chartacea vel subcoriacea. Inflorescentiae usque ad 2 cm longae, cymoso-umbellatae, bracteae lineari-lanceolatae, cca 1 mm longae, ferrugineo-puberulae. Sepala feminea 2—4, pilosa, ovata usque ad 1 mm longa, carpellum 1, stylus disciforme, leviter 2-lobatum.

Holotypus: 25600 HAC; Cuba, Prov. Oriente (Prov. Guantánamo). Entre Maisi et Los Llanos, Baracoa. Leg.: J. HOLMAN, 5. Jun. 1965.

Specim. exam.: Hacienda Cupeyal, Guantánamo. Leg.: M. BARRO Sept. 1962; 25116 HAC!

Obs.: Altera species cubana *C. Pareira* L. valde variabilis, caulibus albo vel luteo pubescentibus vel tomentosis, foliis 2—10 cm longe petiolatis, orbiculari-cordatis vel reniformibus, supra puberulis vel glabrescentibus, subtus pubescentibus vel tomentosis et opacis, nervis leviter conspicuis non reticulato-prominentibus, inflorescentiis usque ad 15 cm longis, bracteis orbicularibus, 6—18 mm longis omnino differt.

Fam.: **Annonaceae**

Xylopia Acunae Borhidi et Del-Risco sp. n.

Frutex vel abor parva. Rami hornotini-angulati, striati adpresse albido- vel ferrugineo-strigulosi setosi, veteriores glabrescentes postremo glabri, teretes, brunnei, longitudinaliter et sparse transversaliter fissurati, lenticellis orbicularibus minutis, satis dense obsiti. Stipulae e basi late triangulari abrupte acuminatae et subulatae usque ad 1 mm longae. Folia 2—5 mm longe petiolata, petiolis minute puberulis, supra canaliculatis praedita, elliptica, oblongo-elliptica vel oblongo-obovata, basi cuneata apice rotundata vel obtusa, emarginata, 2—5 cm longa et 1—2,2 cm lata, nervo medio supra leviter impresso, apicem versus in sulco prominulo, subtus bene prominenti, utrinque sparse puberulo ve glabrescenti, lateralibus utroque latere 4—6, supra tenuissime prominulis vel obsoletis, subtus manifestius prominulis, ante marginem arcuato-conjunctis et anastomosantibus, lamina utrinque opaca glabra, utrinque prominenti-punctata, margine leviter crenulata, plana, chartacea. Flores in axillis foliorum 1—2, fasciculati. Bracteae triangulari-ovatae, cca 1 mm longae, acutae, dorso carinatae et puberulae. Pedicelli 1—2 mm longi puberuli. Alabastra tantum visa, oblongo-ovata, basi leviter dilatata, 2—2,5 mm longa, extus minutissime puberula vel glabrescentia. Cetera ignota.

Holotypus: 27266 HAC; Cuba; Prov. Las Villas, Sierra de Escambray. Pico Potrerillo. Leg.: E. DEL-RISCO 21. Nov. 1972.

Fam.: **Caesalpiniaceae**

Cassia Acunae Borhidi Acta Bot. Acad. Sci. Hung. **22:** 298 (1976); fig. 1

Arbusto de hojas compuestas, con peciolos de 4—5 mm de largo; foliolos 14—20 pares, 4—7 cm de largo, lanceolados, raquis 15—25 mm de largo. Inflorescencia corimboso-paniculada, multiflora; sepalos exteriores 4—5 mm, interiores desiguales, suborbiculares a ovales, 6—8 mm de largo, pelosos en el margen; pétalos estipitados en 2—3 mm de largo, el limbo suborbicular de 9—11 mm de largo y 8—10 mm de ancho.

Holotipo: HAC 22698 ! Cuba; Prov. Pinar del Rio; La Cajalbana, junto al arroyo La Palma. Col.: J. ACUÑA, 27. junio, 1961. Isotipos: HAC, BP.

Fig. 1. Holotipo de *Cassia Acunae* Borhidi (22698 HAC)

Espécie obviamente afin al *C. Gundlachii* Urb. descrita como endémica de las Sierras de Nipe y Cristal (prov. Oriente), la que difiere por tener hojas de peciolos 2—3 cm de largo, raquis 6—15 cm de largo, foliolos 5—10 pares, menores y flores mas grandes.

Fam.: **Euphorbiaceae**

Pera longipes Britt. et Wils.

(Syn.: *Pera pallidifolia* Britt. et Wils.)

Arbor parva, dioica, usque ad 6—8 m alta. Rami hornotini plerumque pruinosi, albicantes, veteriores nigricantes, omnes glabri. Folia alterna, 2—10 mm longe petiolata, obovata, vel oblongo-obovata usque ad oblongo-lanceolata, antice rotundata vel truncata et emarginata, basi longe attenuata et cuneata, nervo medio utrinque prominenti, sicut lateralibus utroque latere 4—8, supra obsoletis, subtus manifeste prominulis, lamina supra pallide viridis vel in sicco nigricans, juvenilis subtus albo-pruinosa vel pallide glaucescens, adolescens pallide glaucescens vel postremo pallide viridis rariter nigricans, utrinque elepidota, glabra, subcoriacea. Involucra mascula 5—30 mm longe pedunculata, fasciculata in axillis; pedunculus glaber. Prophylla 2 semiorbiculata vel late ovata, valde inaequalia, unum majus 1 mm longum et 1,5—2 mm latum, alterum 3—4-plo minus, ferrugineo-lepidota; involucrum ipsum in statu aperto ovatum vel ellipticum 8—12 mm longum, glabrum vel dissite lepidotum. Flores masculi 3, calyx staminibus $\pm$ aequilongus, 3—5 lobatus, lobi irregulariter laciniato-dentati; stamina 4—9, filamenta crassa, inaequalia, basi vel usque ad dimidium connata, brevissime puberula, antherae quadratae. Flores feminei in eodem receptaculo subhermaphrodito extus adjecti 3—4, plus-minus rudimentarii, ovaria dense lepidota, ovalia, stigmatibus subsessilibus orbiculatis rudimentariis. Inflorescentia feminea 1,5—2,5 cm longe pedunculata, pedunculo glabro, 2—4-flora; flores subsessiles, dense ferrugineo-lepidoti, pedicelli fructiferi usque ad 5 mm longi. Capsulae breviter obovatae glabrae vel parce lepidotae, 11—13 mm longae.

Obs.: Las dos especies descritas por BRITTON y WILSON estan basados a dos ejemplares masculos de distinta fase ontogénica de la misma espécie. *P. longipes* y *P. pallidifolia* no tienen caracteres vegetativos distintos, el largo del peduncelo, la forma y tamaño del involucro dependen primeramente del estado de su evolución. Además los involucros masculos y subhermafróditos (que tienen flores masculas y femeninas incompletas en el mismo involucro) se difieren en forma y tamaño. Por esta razón la *P. pallidifolia* no puede ser considerada como espécie distinta y válida y hay que suprimirla, cómo posteriormente descrita.

Specimina examinata: SHAFER 4416, Oriente: Navas, Campo Buena Vista isotipo de *Pera longipes* en SV!, — SHAFER 4183, Oriente: Rio Yamanigüey, Campo Toa (isotipo de *Pera pallidifolia* en HAC!).

Pera orientensis Borhidi sp. n.

(*P. ovalifolia* sensu LEÓN et ALAIN, non URBAN) Fig. 2

Arbor parva usque ad 4—5 m alta. Rami hornotini dense lepidoti, ferruginei, internodiis 0,5—1 cm longis. Folia alterna, 3—7 mm longe petiolata, elliptica vel oblongo-elliptica, basi attenuata et in petiolum protracta, rotundata vel obtusa, leviter emarginata, 3—6 cm longa et 1,5—3 cm lata, nervo medio supra prominulo, lateralibus utroque latere 5—8, utrinqueaprominulis, supra tenuiter anastomosantibus, subtus conspicue reticulatis, supra in sicco nigricantia, juvenilia etiam perfecte glabra, adulta lucida, subtus brunnescentia, nitida, dissite lepidota, margine tenuiter recurva, chartacea vel subcoriacea. Inflorescentiae masculae axillares 1—3, pedunculis 5—7 mm longis, 1 mm crassis dense lepidotis suffulta. Involucra solitaria, prophylla 2, semiorbicularia, altera 3-plo breviora, dense lepidota. Flores masculi 2, calyx breviter turbinatus 5-lobatus, irregulariter lacero-dentatus, stamina 5—6, filamenta brevia, crassa, inaequalia, basi connata, superne libera. Flores feminei in inflorescentia corymbosa 2—5-flora,

Fig. 2. Holotipo de *Pera orientensis* Borhidi (ALAIN 8039 HAC)

5—7 mm longe pedunculata axillares vel laterales. Pedicelli usque ad 1 mm, fructiferi 3—4 mm longi, sicut ovarium dense lepidoti. Capsula globosa, 6—8 mm longa, valvis 8—10 mm longis, satis dense lepidota, endocarpium 0,5 mm crassum. Semina obovato-orbiculata, 4 mm longa et lata, inferne 2 mm lata.

Holotypus: ALAIN 8039 HAC ! Cuba; Prov. Oriente, Sierra de Nipe, Cayo La Plancha, bosque humedo, in alt. approx. 700 m.s.m. Leg.: ACUÑA, ALAIN et RAMOS, 21. Apr. 1960. Isotypus SV ! Flor. masc. Paratypus: ALAIN 8037 HAC ! Ibidem, flor. fem. Leg.: ACUÑA, ALAIN et RAMOS 21. Apr. 1960.

Specim. exam.: Sierra del Cristal: Pico del Cristal UO 88. Leg.: LÓPEZ FIGUEIRAS, 25. Aug. 1959. fruct. — Sierra de Cristal: Entre Corea y Los Mulos, LF. 211, Leg.: LÓPEZ FIGUEIRAS 27. Aug. 1959. — Cayo Verde, ALAIN et LÓPEZ FIGUEIRAS 4524. 26. Dec. 1955. — Rio Lebisa, alt. 600 m. UO. 169. LÓPEZ FIGUEIRAS, 26. Aug. 1959. — Falda Sur del Pico Cristal, ALAIN et LÓPEZ FIGUEIRAS 4773; 28. Dec. 1955. — Ibidem 4700; 4797. — Sierra de Iberia, Cumbre; Taco Bay; UO 2238; LÓPEZ FIGUEIRAS 25. Jul. 1960.

Obs.: *P. ovalifoliae* Urb. (e prov. Camagüey: Galbis) affinis, quae a specie nostra foliis majoribus pergamaceis, juvenilibus supra lepidotis, 7—10 mm longe petiolatis, nervis lateralibus utroque latere 8—10, subtus obsoletis et non reticulatis, pedunculis fructiferis 1,5—2,5 mm longis, pedicellis 2 mm longis capsulis majoribus, non lepidotis differt. E desciiptione urbaniana EKMAN e Cupey (Oriente) huc recedit.

Pera polylepis Urb. ssp. **moaënsis** Borhidi ssp. n.

A typo differt: foliis 6—12 cm longis et 2,5—5 cm latis, nervis lateralibus utroque latere 9—12, supra tenuiter impressis, laminis foliorum squamulis non imbricatis, subtus dissite lepidotis.

Holotypus: CLEMENTE 3885 HAC; Cuba; Prov. Oriente: Charrascos, Rio Yagrumajes, Moa. Leg.: CLEMENTE et ALAIN 18. Jul. 1944.

Specim. exam.: Aserrio de Moa, CLEMENTE 5005, 17. Apr. 1946. HAC — Ibidem, CLEMENTE et CRISÓGONE 4955, 15. Apr. 1946 HAC — Taco Bay, SMITH 602, 8. Mai. 1952. HAC — Camino de Centeno, Cananova, CLEMENTE, ALAIN et CRISÓGONE 6892, Jul. 1947.HAC — Playa La Vaca, Moa; CLEMENTE, NESTOR et CRISÓGONE 6142, Aug. 1948. Ibidem, M. VICTORIN, CLEMENTE et ALAIN 21832, Apr. 1943. — Aeropuerto de Moa, LEÓN, M. VICTORIN et Sra BUCHER, 20701, 27. Mart. 1942. — Yamanigüey, Taco Bay, LÓPEZ FIGUEIRAS UO 760. 12. Apr. 1960. — Charrascos de La Ermita, Yunque de Baracoa, ACUÑA et ALAIN 7587, 15. Jan. 1960. — Sierra de Nipe: Rio Grande, Preston SMITH 532. 29. Apr. 1952. — Cerro de Miraflores, Cananova, M. VICTORIN et ALAIN 21461; Apr. 1953. — Este de Playa de Moa, CLEMENTE 5005.— Ibidem ALAIN 991, Jul. 1949. — Charrascal de la Cuaba, Baracoa UO 891 LÓPEZ FIGUEIRAS, 14. Apr. 1960.

Fam.: **Cyrillaceae**

Purdiaea maëstrensis Borhidi et Catasus sp. n. (Fig. 3)

Arbor parva; rami hornotini teretes, glabri, veteriores albicantes, cicatricibus foliorum dense obtecti. Folia alterna sessilia, oblanceolata, antice attenuata, apice ipso obtusa, mucronata vel emarginata, basi longe acuminata, 4,5—8 cm longa et 1,4—2,8 cm lata, utrinque

Fig. 3. Holotipo de *Purdiaea maestrensis* Borhidi et Catasus (López Figueiras 2304, HAC)

glabra, nervo medio supra impresso, subtus prominenti, reticulatione venarum utrinque tenuiter prominula, lamina supra in sicco brunnea, subtus pallidiora, margine integra, chartacea. Inflorescentia elongata cum pedunculo 6—12 cm longa, rhachibus glabris. Bracteae ovatae, 3—6 mm longae. Sepala externa in anthesi 12—15 mm longa, triangulari-ovata, apice acuta et mucronulata, secunda et tertia non multo minora (8—9 mm longa), in fructu non crescentia, petala basi connata subaequalia, prima 10 mm, altera 8—9 mm longa, apice acuta et apiculata, margine minute ciliata; stamina 10, ad basim corollae adnata, antherae oblongae, 3 mm longae, apice acutae et apiculatae, filamentis (2 mm) longiores. Stylo sepalis minore.

Holotypus: LF 2304 HAC; Cuba, Prov. Oriente; Sierra Maestra; Rio de la Bayamesa, in alt. approx. 1600 m.s.m. 11. Aug. 1955, López Figueiras. Isotypus HAC.

Obs. I.: Ekman 14738. Sierra Maestra, Arroyo Corojo; cerca de Nagua. 5. Aug. 1922. huc pertinet.

Fig. 4. Isotipo de *Purdiaea nipensis* M. Vict. (León et Marie-Victorin 19837 HAC)

Obs. II.: *P. nipensis* M. Vict. et León (Fig. 4) affinis, quae a specie nostra foliis 2,5—4,5 cm longis et 1—1,5 cm latis, apice rotundatis, inflorescentiis 4—5 cm longis, rhachibus pubescentibus, sepalis apice rotundatis vel obtusis, minutis, sepalis secundis, et tertiis petala superantibus certe specifice differt.

El ejemplar fructifero colectado por Ekman (14738) fue clasificado preliminariamente y con cierta duda como *P. nipensis*. Los ejemplares floriferos colectados por López Figueiras no dejan alguna duda sobre lo que las pobla-

ciones crecientes en la Sierra Maestra tienen caracteres bastante constantes distintos, no solo en el tamaño de las hojas sino en la inflorescencia también. Es muy notable que entre todas las espécies orientales de este género *Purdiaea maestrensis* es la única, que no crece sobre rocas serpentinas.

Fam.: **Aquifoliaceae**

Ilex baracoënsis Borhidi sp. n.

Frutex; rami veteriores albo-cinerei, leviter angulati et longitudinaliter sulcati, glabri. Folia 2—4 mm longe petiolata, petiolis anguste alatis, glabris suffulta, late obovata, suborbiculata vel subobcordata, apice rotundata vel truncata, leviter emarginata vel excisa, basi cuneata et in petiolum protracta, 2,5—4,5 cm longa et 1,8—4 cm lata, anguste decurrentia, nervo medio supra inferne prominulo, apicem versus leviter impresso, subtus inferne prominulo, apicem versus obsoleto, lateralibus utroque latere 4—6, obsolete prominulis vel inconspicuis, subtus obsoletis vel plerumque nullis, lamina supra nitidissima, subtus pallida opaca, utrinque glabra, margine tenuiter recurva, coriacea. Inflorescentiae axillares, 1—4 per nodos, umbellatae, 3—4-florae. Pedunculi 2—5 mm longi, flores 4-meri, 1—2 mm longe pedicellati, glabri. Fructus non visus.

Holotypus: UO. 726. Cuba; Prov. Oriente, Bahia de Taco, Camino de Yamanigüey, Moa; en charrascos. Leg.: M. López Figueiras 12. Apr. 1960. HAC Isotypus: HAC

Obs.: *Ilex hypaneurae* O. C. Schmidt affinis, quae a specie nostra foliis oblongo-elipticis obovatis vel oblongo-obovatis et inflorescentiis puberulo-pilosis clare differt.

Ilex hypaneura O. C. Schmidt var. **nudicalyx** Borhidi var. n.

A typo differt: inflorescentiis masculinis fasciculatis, glabrescentibus, calyce glabro.

Holotypus: UO. 757. Cuba; Prov. Oriente (Prov. Holguin). En charrascales del camino Yamanigüey, Bahia de Taco, Moa, Leg.: M. López Figueiras 12. Apr. 1960. SV. Isotypus: SV!

Fam.: **Ochnaceae**

Ouratea × Acunae Borhidi hybr. nova
(*ilicifolia × elliptica*)

Frutex usque ad 2 m altus. Rami teretes tenuiter transversim striati. Folia 2—4 mm longe petiolata, ovata vel elliptica, basi obtusa, rotundata vel subcordato-truncata, apice rotundata vel attenuata et pungenter acuta, 2,5—9 cm longa et 2—3,5 cm lata, nervo medio utrinque prominenti, lateralibus numerosis apicem versus arcuatis dense reticulato-conjunctis

utrinque prominulis, margine undulata vel dentibus satis remotis 0,5—1 mm longis, irregulariter serrulato-denticulata, rigide et crasse coriacea. Inflorescentia paniculata, 3—5 cm longa, plerumque laxa, pauciflora, glabra. Alabastra ovata, 4—5 mm longa, receptaculum evolutum non visum.

Holotypus: ACUÑA 16007 HAC Cuba; Prov. Pinar del Rio, Carretera de Luis Lazo.

Specim. exam.: Prov. Pinar del Rio, Cañada del Pinar, Cerro de Cabras, leg. ALAIN 1845. 19. Mai. 1951. — Remates de Guane, Sabanas; LEÓN et M. VICTORIN 18723, Jan. 1939.

Fam.: **Oleaceae**

Linociera

Clave analítica para las espécies cubanas:

1 a Anteras lineales, casi tan largas como los pétalos .... 1. **L. ligustrina**
b Anteras oblongas a elipticas de menos de la mitad del largo de los pétalos 2
2 a Hojas cartáceas con grupos de pelos en las axilas de los nervios en el envés 3
b Hojas coriáceas o subcoriáceas sin grupos de pelos en las axilas de los nervios en el envés 4
3 a Hojas de 6—15 cm de largo, cáliz algo ciliado, lóbulos connados hasta cerca de la mitad, pétalos de 10—22 mm de largo .... 2. **L. domingensis**
b Hojas de 4—8 cm de largo, cáliz peloso, lóbulos libres casi hasta la base, pétalos de 6—8 mm de largo .... 3. **L. Bakeri**
4 a Hojas mayormente agudas o mucronado-agudas en el ápice, ramas de las inflorescencias pelosas 5
b Hojas redondeadas o estrechadas en un ápice obtuso mayormente emarginado, ramas del las inflorescencias lampiñas o pelosas 6
5 a Hojas de 4—7 cm, nervios laterales invisibles o muy poco hundidos, no reticulados arriba, panoja corta glomerada, pedicelos hasta 1 mm, pétalos planos de 6—8 mm de largo .... 4. **L. axilliflora**
b Hojas de 5—11,5 cm, mucronado-agudos, nervios laterales hundidos, finamente reticulados en el haz; pedicelos de 2—5 mm de largo, pétalos plegados, de 4—6 mm de largo .... 5. **L. Moncadae**
6 a Inflorescencia pelosa, lóbulus de cáliz libres casi hasta la base; hojas no reticulado-venosas en ambas caras 7
b Inflorescencia mayormente glabrescente; lóbulos del cáliz connados hasta la mitad; hojas reticulado-venosas en ambas caras ... 6. **L. bumelioides**
aa Hojas lanceoladas a oblongo elípticas, estrechadas en ambos extremos .... ssp. **bumelioides**

bb Hojas obovadas, redondeadas en el ápice ± largamente atenuadas en la base .... ssp. **obovalis**

7 a Hojas oblongo-obovadas, 6—9 cm de largo y de 1,5—2,5 cm de ancho, redondeadas en el ápice, el margen revoluto. Inflorescencias terminales

Fig. 5. Holotipo de *Linociera Acunae* Borhidi et Muñiz (Roig 1506 HAC)

Ramas de las mismas glabras, pétalos de 5—5,5 mm de largo .... 7. **L. cubensis**

b Hojas elipticas, de 5—9 cm de largo, 2,0—4,5 cm de ancho, estrechadas ± igualmente en ambos extremos, el margen plano. Inflorescencias axilares, ramas de las mismas pubérulas, pétalos de 7—10 mm de largo .... 8. **L. Acunae**

Linociera Acunae Borhidi et Muñiz sp. n. (Fig. 5)

Frutex vel arbor humilis. Ramuli hornotini puberuli, veteriores albido-cinerei, lenticellis suborbicularibus sparsissime dispositis suffulti. Folia 8—15 mm longe petiolata, elliptica, antice brevissime leviter acuminata, apice ipso obtusa, emarginata vel brevissime mucronata, basi breviter attenuata vel obtusiuscula rariter rotundata et in petiolum protracta, 5—9 cm longa et 2—4,5 cm lata, nervo medio supra impresso, subtus prominenti, lateralibus utroque latere 5—7, supra leviter impressis et obsolete reticulatis, subtus manifeste prominentibus, ante marginem conjunctis et laxe reticulatis, lamina utrinque opaca, subtus obsolete punctata, margine integra, ± plana, utrinque glabra, subcoriacea.

Inflorescentiae axillares et terminales 2—3,5 cm longae, dense flavo- vel ferrugineo-pubescentes. Pedunculi 5—10 mm longi, pedicelli 1—2 mm longi. Calyx usque ad basim lobatus, lobi 4, triangulares, ± 1 mm longi, apice obtusi utrinque dense pubescentes; petala 7—10 mm longa, applanata, medio ± 0,5 mm lata; stamina 2, cca 1 mm longa antherae ovatae vel ellipticae, filamenta antheris aequilongis, stylus subnullus, apice triangulari-capitatus, leviter bilobatus, ovario glabro brevior.

Holotypus: Roig 1506 ! Cuba, Prov. Camagüey: "savannis" serpentinosis ad Puerto Principe. Leg.: Jan. 1917. P. F. Borrás. HAC !

Linociera Moncadae Borhidi et Muñiz sp. n. (Fig. 6)

Frutex vel arbor parva usque ad 4—5 m alta. Ramuli hornotini breviter flavo- vel ferrugineo-pilosi, veteriores albido-cinerei lenticellis oblongo-ellipticis satis dense obtecti. Folia 7—12 mm longe petiolata, oblanceolato-elliptica, levissime asymmetrica, apice acuta vel obtusiuscula et rigide mucronata, basi angustata et in petiolum protracta, 5,5—11,5 cm longa et 1,8—4 cm lata, nervo medio supra anguste et profunde impresso, subtus prominenti, lateralibus utroque latere 8—12, supra anguste impressis, subtus leviter sed manifeste prominulis ante marginem arcuato-conjunctis, supra obsolete impresso areolato-reticulatis, subtus obsolete reticulatis et punctulatis, utrinque nitidula et glaberrima, margine tenuiter recurva, rigide coriacea. Inflorescentiae axillares vel laterales, paniculatae, 5—11-florae, 1,2—2 cm longae. Paniculae flavo- vel ferrugineo-pubescentes, pedicelli 2—5 mm longi, 1—1,5 mm longe bracteolati, calyx solummodo basi connatus, lobi 4, anguste triangulares, obtusi, extus pubescentes, intus in nervo medio pilosi, ceterum glabri. Petala involuta, 4—6 mm longa; stamina 2, filamenta brevissima, 0,5 mm longa, antherae ellipticae filamentis duplo longiores, stylus ovario glabro ovato subaequilongus, apice capitatus, profunde bilobatus.

Holotypus: 27341 HAC! Cuba, Prov. Oriente, Sierra de Moa; in fruticetis sempervirentibus solo serpentinico-lateritico ad Mina Melba alt. cca. 350—400 m.s.m.; Leg.: Milagros Moncada 31. Mai. 1972. Isotypi: HAC, BP.

Linociera bumelioides Griseb. ssp. **obovalis** Borhidi et Muñiz ssp. n.

A typo differt: foliis obovatis, apice rotundatis et plerumque emarginatis basi longe cuneatis.

Holotypus: 24571 HAC ! Zona de Puerto Padre. Leg.: M. Curbelo 1932. Isotypus: HAC !

Fig. 6. Holotipo de *Linociera Moncadae* Borhidi et Muñiz (27341 HAC)

Specimina examinata: Puerto Padre, leg.: M. CURBELO 303. Nov. 22. 1930, 27. Mai 1931. — 27090 HAC. Gran Piedra, Sierra Maestra, leg.: Fitoquimicos alemanes.

Forestiera Ekmanii Borhidi sp. n.

Frutex dense ramosus; ramuli hornotini teretes brevissime puberuli, veteriores glabri, brunneo-purpurei levissime striati. Folia opposita vel fasciculata, usque ad 1 mm longe petiolata, ovata, late elliptica vel suborbiculata, antice attenuata et obtusa vel rotundata, sub medio latissima basi rotunda et in petiolum decurrentia, 4—9 mm longa et 3—6 mm lata, utrinque opaca et pallide viridia, subtus prominenter punctata, margine integra et tenuiter revoluta. Inflorescentiae axillares, umbellatae, plerumque 1—2-florae 1—3 mm longe pedunculatae, bracteae orbiculares, persistentes, pedicelli 0,5—2 mm longi, plerumque glabri. Fructus ellipticus, 5—6 mm longus et 3—4 mm latus, superne leviter incrassatus et rotundatus, basi breviter attenuatus et obliquus.

Holotypus: EKMAN 18726 (Roig 3116); Cuba, Prov. Pinar del Rio, Cima de la Sierra de Guane; Guane. Leg.: E. L. EKMAN, 14. Mart. 1924.

Lantanopsis tomentosa Borhidi et Moncada sp. n.

Suffrutex usque ad 1—1,5 m altus. Rami hornotini adpresse albo-pilosi, non vel levissime hispiduli, veteriores brunnei, longitudinaliter striati, glabrescentes. Folia opposita 1—2 mm longe petiolata, oblongo-elliptica, oblongo-lanceolata vel lineari-lanceolata, antice attenuata et acuta, basi longe cuneata, 2—7 cm longa et 0,5—2 cm lata, basi trinervia, nervis supra densissime reticulatis et profunde impressis, areolato-bullata, subtus reticulo prominenti suffulta lamina supra nitida, areolato-bullata, sparse et adpresse pilosula, subtus in nervis adpresse pilosa, inter nervos tomento tenui albo vel postremo cinerascenti obtecta, margine leviter serrulata vel subintegra, plerumque plana, chartacea. Inflorescentiae terminales, capituliformiter cymosae, bracteis ovatis vel oblongo-ellipticis, membranaceis et plerumque glabris. Capitula sessilia, bracteolis 1—2, late ovatis vel subrotundatis, dorso levissime carinatis, apice mucronatis glabrescentibus vel nitidisque glabris suffulta, bracteae involucrales 4, inaequalibus 2—2,5 mm longae glabrae, exteriores 2, late ovatae, apice apiculatae minores, interiores suborbiculares apice plerumque rotundatae vel fimbriatae, exterioribus latiores. Flos bisexualis 1, corolla 1 mm longa, ex involucro leviter exserta, 4-lobata, lobi corollae tubo 3-plo breviores, stamina 4, corolla aequilonga, antherae subglobosae, minutae, flores steriles 2, filiformes; ovarium dense glandulosum, lateraliter compressum, 2 mm longum; achaenium obovatum, 2 mm longum, lentiforme, convexum, marginatum, glandulis deciduis obsitum, demum nigrescens glabrum. Pappi nulli.

Holotypus: 27197 HAC! Oriente: (Prov. Santiago de Cuba), Sierra Maestra; Alto de la Francia, Uvero. Leg.: MILAGROS MONCADA 8. Febr. 1971.

Specimina examinata: Cuba; Sierra Maestra; Margenes de Rio Peladero, Alto de la Valenzuela; Leg.: M. LÓPEZ FIGUEIRAS 2190, 8. Apr. 1955. — Ebenda LÓPEZ FIGUEIRAS 2323. 12. Aug. 1955.

Obs.: *L. hispidulae* Wr. ex Griseb. affinis, quae a specie nostra ramis strigilloso-hispidis, foliis supra ± dense strigilloso-hirsutis, non areolato-reticulatis, subtus in nervis hirsutis inter nervos glabris et flavo-glandulosis, bracteis inflorescentiae et capitulorum linearibus et strigosis, floribus minoribus abunde differt. Altera species *L. Hoffmanii* Pax (ex Santo Domingo) foliis ovatis, 1,5—2,5 cm longis, basi rotundatis, floribus majoribus, ovario atque achaenio vertice piloso clare distincta est.

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CYTOCHEMICAL INVESTIGATIONS OF THE SHOOT APEX OF APPLE TREES I

DNA, DNA- AND RNA-, AND HISTONE CONTENT OF MERISTEMATIC CELL NUCLEI IN TERMINAL BUDS OF SPURS WITH AND WITHOUT FRUITS

By

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For using chemicals regulating flower bud formation, it is necessary to know the conditions within the apical meristem during the transition from the vegetative stage to the reproductive one.

Terminal buds were harvested from spurs bearing fruit and from ones without fruit. Using longitudinal sections the DNA, DNA + RNA and, nucleohistone content in various regions of the apex were measured cytophotometrically. The presence of the fruit induced a lower level of nucleic acids and a higher nucleohistone content. These conditions proved to inhibiting for flower initiation. The absence of the fruit resulted in totally reversed effects, providing favourable pre-conditions for flowering. It seems to be worth while to stress the fact, that apices of these buds (i.e. buds on spurs without fruits) are practically induced for transition to the reproductive state. This induction probably is related to the lack of endogenous growth substances (mainly gibberellins) originating from seedlets of growing young fruit.

Introduction

Many paper have been published recently on treatments by synthetic growth regulators to promote (or to inhibit) flower bud formation in apple trees. However, to use chemicals regulating flower bud formation, it is necessary to establish the conditions within the apical meristem during the transition from the vegetative stage to the reproductive one. According to our preliminary histological and histochemical investigations in the apices of terminal buds on spurs of apple trees (BUBÁN 1970), there is an increase in mitotic activity before changes in shape of the apex. For this reason, an attempt was made to follow changes in nucleic acids and nucleohistones in various meristem tissues of the apices. We had to know, however, whether our data are really in any connection with developmental processes towards the reproductive state.

The only approach to this problem is to use terminal buds of spurs bearing fruit and ones without fruit, respectively. The presence of fruit means a strong inhibition for fruit bud formation, on the other hand, conditions in spure without fruit may be taken for inductive ones for flowering (FEUCHT and ARANCIBIA 1969).

Material and Method

Buds for cytophotometrical investigations were harvested on 20th of June and 7th of July, respectively, that is about the time of transition to the reproductive state. Each bud was located either on spur with fruit (= AF) or without fruit (= AO, see Fig. 1, too). Ethanol : formalin : picric acid 6 : 1 : 1.3 was used for fixation. The 10 to 12 micron-thick sections prepared after embedding in paraplast were investigated. The methods used for measuring
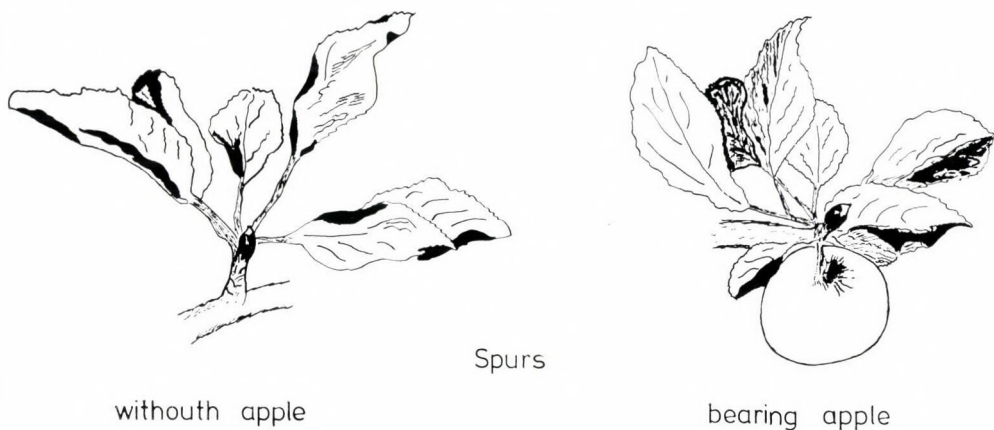
Fig. 1. Spurs (typical fruiting short shoots of apple trees) providing terminal buds for cyto chemical investigations

DNA content of cell nuclei have been given earlier (HESEMANN and BUBÁN 1973). The SCHIFF reagent was prepared according to the standard technique of GRAUMANN (1953), but with trichloro acetic acid (BLOCH and GODMAN 1955). According to PEARSE (1961, in: ARNOLD 1968) and MITCHELL (1968) longitudinal sections for DNA + RNA estimation were stained by gallocyanine-chromealum (GCA), histone content was investigated as employed by ALFERT and GESCHWIND (1953). In order to measure DNA content after staining with GCA, a pretreatment by ribonuclease was made (0.2 mg/ml dest. water, at 40 °C, 3 hours). As a possibility of estimating DNA and RNA content in the same nuclei, several sections were stained with coriphosphin-0-Feulgen and GCA described by KIEFFER et al. (1969). Measurements (with ZEISS UMSP-I universal microspectralphotometer) were carried out at 550, 570 and 630 nm in sections stained with SCHIFF reagent, GCA and Fast Green FCF, respectively. Data of measurements have been expressed as AU (arbitrary unit).

Results and Discussion

Before discussing the results of measurements, a comment is required on the matter of apex terminology. The different zones are specified on the basis of their histological characters (for example: cell size, direction of cell division, activity in differentiation processes leading to reproductive state, etc.). In terms of *tunica-corpus* concept of apical organization, the zone corresponding to the *tunica* should be divided into two regions which have been called Z_1 and Z_2, each of them has two layers of meristem cells, (see figures A—B, resp.).

As underlying part (corpus or central meristem) is situated axially (Z_3) and it passes below into the pith-rib meristem (Z_4). It is worth mentioning that this organization undergoes a change during flower bud differentiation. Namely, following an increase in mitotic activity all over the apex, but before the morphological change in shape of its form, the central meristem can be seen immediately surrounding to the subdermatogen (the second cell layer within the Z_1). Details of this histological differentiation are given elsewhere (BUBÁN 1970, BUBÁN and SIMON 1978).

The results of investigations are presented in Figures 2 to 6, and in Table 1. Test of significance is summarized in Table 2 and Table 3.
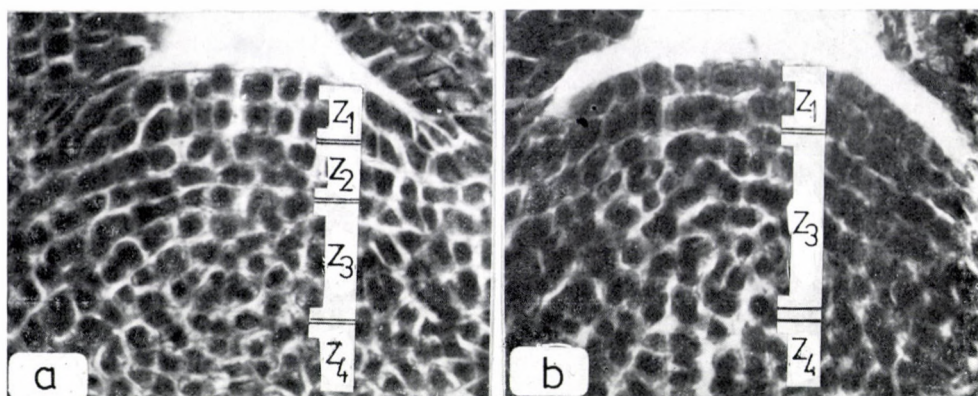
Fig. A—B. Structure of the apex in vegetative stage (a) and, following the histological differentiation, in reproductive stage (b) —. Z_1 = dermatogen and subdermatogen, Z_2 = adventive tunica layer, Z_3 = central meristem, Z_4 = pith meristem

It is clear from Fig. 2 that nuclear DNA content estimated is significantly divergent in Z_3, Z_4 and Z_2 to Z_4. There is no considerable difference between data in Z_1 and Z_2, however, this is not surprising. Namely, the lateral part of the first layer and the same part of the second cell layer (i.e. the place of leaf primordia initiation) show an enhanced mitotic activity both in vegetative and reproductive apices. The uniformity in nuclear DNA content demonstrated in AO apices of Fig. 2 should be taken as a developmental stage preparing the next step, i.e.: cells entering mitosis all over the apex.

Figure 3 shows essentially the same — that is more nuclear nucleic acid in samples from spurs without fruit (sample AO). Nevertheless, this statement
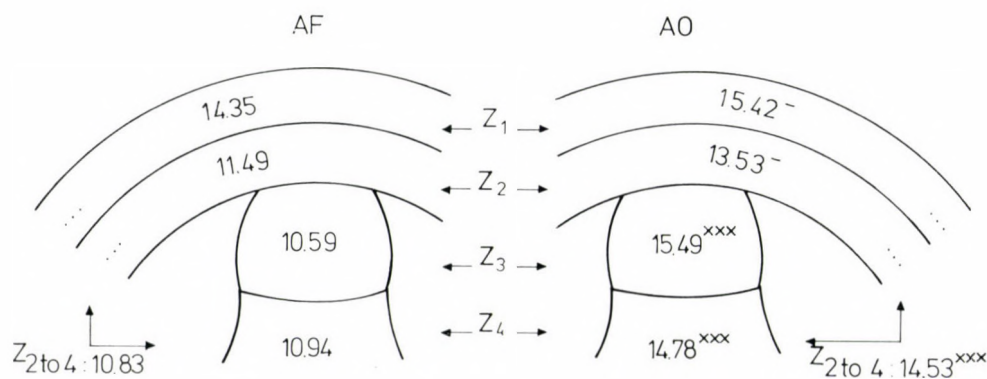
Fig. 2. Nuclear DNA content in the apices of terminal buds of spurs bearing apple (AF) and without apple (AO)
staining: Feulgen procedure, values in arbitrary units; significant within the same meristem zone, between "AF" and "AO" buds at 1% = xxx, 2% = xx, 5% = x, — = insignificant

Table 1

Nucleic acid and histone level of cell nuclei in apices of buds from spurs with fruit (AF) and without fruit (AO)

Samples	Zones within the apex	Type of bud sample	Staining	Estimation of nuclei content for	Number of nuclei estimated, n	Average $\bar{x}$ in AU	Standard deviation, s	Treshold value
I.	Zone 1	AF	Std.-Feulgen	DNA	50	14.35	4.65	0.10
	Zone 2—4				58	10.83	3.17	
	Zone 2				29	11.49	2.57	
	Zone 3				7	10.59	1.42	
	Zone 4				22	10.94	2.78	
II.	Zone 1	AO	Std.-Feulgen	DNA	32	15.42	4.27	0.10
	Zone 2—4				65	14.53	4.51	
	Zone 2				24	13.53	4.66	
	Zone 3				19	15.49	3.74	
	Zone 4				22	14.78	4.92	
III.	Zone 1	AO	GCA	DNA + RNA	9	10.24	4.51	0.25
	Zone 2—4				37	9.09	6.24	
	Zone 2				15	10.31	6.92	
	Zone 3				7	3.94	1.94	
	Zone 4				15	10.26	5.85	
IV.	Zone 1	AF	GCA	DNA + RNA	20	6.14	4.24	0.25
	Zone 2—4				38	1.48	2.38	
	Zone 2				12	1.13	2.83	
	Zone 3				11	0.73	1.54	
	Zone 4				15	2.32	2.39	
V.	Zone 1	AO	GCA	DNA + RNA	20	10.80	5.70	0.16
	Zone 2—4				47	9.24	4.10	
	Zone 2				18	9.55	4.11	
	Zone 3				10	7.65	3.65	
	Zone 4				19	9.79	4.31	
VI.	Zone 1	AO	first	DNA	25	9.95	3.46	0.16
	Zone 2—4		RNase		20	6.70	3.20	
	Zone 2		and than		11	7.50	3.42	
	Zone 3		GCA		3	4.58	3.14	
	Zone 4				6	5.79	3.40	

VII.	Zone 1	AF	GCA + C—O-Feulgen	DNA + RNA	21	2.06	1.15	0.10
	Zone 2—4				38	1.56	1.24	
	Zone 2				16	2.06	1.31	
	Zone 3				8	1.46	0.93	
	Zone 4				14	1.04	1.14	
VIII.	Zone 1	AO	GCA + C—O-Feulgen	DNA + RNA	36	3.60	2.48	0.10
	Zone 2—4				47	2.03	1.55	
	Zone 2				19	1.45	1.38	
	Zone 3				9	1.71	1.51	
	Zone 4				19	2.76	1.50	
IX.	Zone 1	AF	Fast Green FCF	Histone	9	0.96	0.59	0.06
	Zone 2—4				37	1.54	0.91	
	Zone 2				15	1.44	0.85	
	Zone 3				12	1.12	0.68	
	Zone 4				10	2.18	0.94	
X.	Zone 1	AO	Fast Green FCF	Histone	17	0.31	0.21	0.06
	Zone 2—4				36	0.62	0.65	
	Zone 2				14	0.40	0.28	
	Zone 3				10	0.29	0.18	
	Zone 4				12	1.16	0.85	

Remarks: 1. Zones within the apex see in figures.
2. Std.-Feulgen = Standard-Feulgen, GCA = Gallocyanine-chromealum, C—O-Feulgen = Coriphosphin—O-Feulgen.
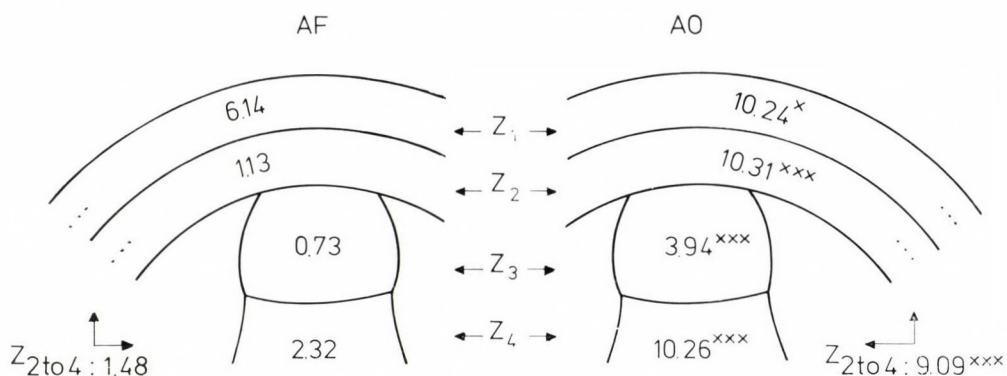
Fig. 3. Nuclear DNA and RNA content in the apices of terminal buds of spurs bearing apple (AF) and without apple (AO) — staining: Gallocyanine chromealum, values in arbitrary units; for testing significance see Fig 1, Table 2 and 3 resp.
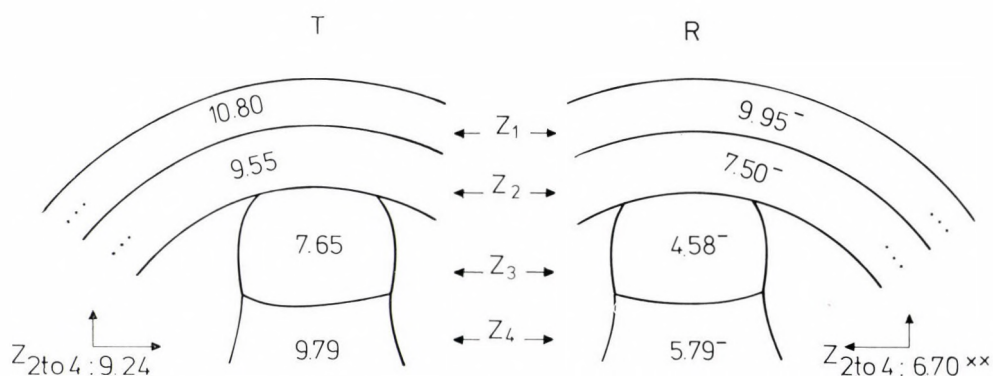
Fig. 4. Total nucleic acid (T) and DNA content after RNase treatment (R) in the nuclei of AO buds — staining: Gallocyanine chromealum, values in arbitrary units; for testing significance see Fig. 1, Table 2 and 3 resp.
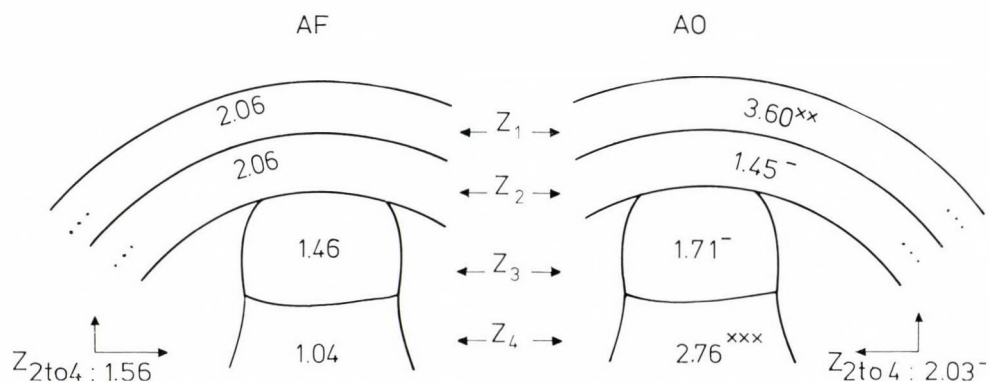
Fig. 5. Nuclear DNA and RNA content in the apices of terminal buds of spurs bearing apple (AF) and without apple (AO) — staining: Gallocyanine chromealum and Coriphosphin-O-Feulgen, values in arbitrary units; for testing significance see Fig. 1, Table 2 and 3 resp.

Table 2

Statistical testing of the significance between averages listed in Table 1

Samples	II.	IV.	V.	VI.	VII.	X.
I. Zone 1	—					
Zone 2—4	× × ×					
Zone 2	—					
Zone 3	× × ×					
Zone 4	× × ×					
III. Zone 1		×				
Zone 2—4		× × ×				
Zone 2		× × ×				
Zone 3		× × ×				
Zone 4		× × ×				
VI. Zone 1			—			
Zone 2—4			× ×			
Zone 2			—			
Zone 3			—			
Zone 4			—			
VIII. Zone 1				+	× ×	
Zone 2—4				+	—	
Zone 2				+	—	
Zone 3				+	—	
Zone 4				+	× × ×	
IX. Zone 1						× × ×
Zone 2—4						× × ×
Zone 2						× × ×
Zone 3						× × ×
Zone 4						× ×

Remarks: 1. Significant at 5% = ×; at 2% = × ×; at 1% = × × ×; no test for significance = = +; insignificant = —.
2. Explanation of other abbreviations is given in Table 1.

is valid for Z_1 and Z_2, as well, probably owing to the higher RNA content in nuclei of cells in AO samples. Within the total nucleic acid content revealed by staining with GCA, it is the DNA which has a considerable proportion of values recorded (Fig. 4). The trend of data in Fig. 5 is comparable to the results presented above, however, these data are less convincing.

Table 3

Statistical testing of the significance between various zones within the apex

Samples	Zones 1/2	Zones 1/3	Zones 1/4	Zones 2/3	Zones 2/4	Zones 3/4
I.	×××	×	×××	—	—	—
II.	—	—	—	—	—	—
III.	—	×××	—	×	—	××
IV.	×××	×××	×××	—	×	×××
V.	—	—	—	—	—	—
VI.	—	××	××	—	—	—
VII.	—	—	××	—	×	—
VIII.	×××	×	—	—	×××	—
IX.	—	—	×××	—	×	×××
X.	—	—	×××	—	×××	×××

Remark: Explanation of the abbreviations is given in Table 1.

These findings about nucleic acid level of cell nuclei correspond to the results published formerly (ZEEVAART 1962, GIFFORD 1963 and papers in BERNIER 1970). Furthermore, it is worth mentioning the results reported by SCHMIDT (1977). Data of his paper suggest that *there is a relationship between intensity of flower primordia initiation and rate of RNA synthesis in buds of apple cultivars.*

Another nutritional aspect of the flower bud formation. Histological and cytochemical investigations in apices of many species show that the mitotic and metabolic activity in the central zone of the apex is greatly enhanced before its morphological changes (= flower primordia formation) can be observed. This activation is a real requisite for initiating flower primordia development, quite generally (see papers in BERNIER 1970), in apple tree as well (BUBÁN 1970, BUBÁN and SIMON 1978). The change in activity of the central meristem is known to be controlled by hormonal factors as well as nucleic acid metabolisms. Recently SACHS (1977) has suggested that "*. . . according to the nutrient diversion hypothesis, induction causes activation of the central zone, a requisite for floral initiation and early development, through greater availability of nutritional factors (assimilates).*" Furthermore "*Thus, control of flowering by chemical or environmental factors may be an indirect result of influences on assimilate supply distribution and not upon specific morphogenetic influences in the shoot apical meristem.*"

It is assumed that nucleic acid replication as well as mitotic activity are regulated by nucleohistones. For investigating them, sections were prepared from the same apices providing sections for nucleic acid staining. According to

the data of Fig. 6, nucleohistone content is significantly lower in AO buds than it is in AF apices. This fact suggests that — in a surprising way — there is no parallelism in DNA and nucleohistone level in these cells, and/or these divergences of nucleic acid: histone ratio should be an important factor in this developmental stage of flower bud formation. Nevertheless, investigating nucleohistones in this respect provided rather inconclusive results (GIFFORD 1963, KNOX and EVANS 1966).
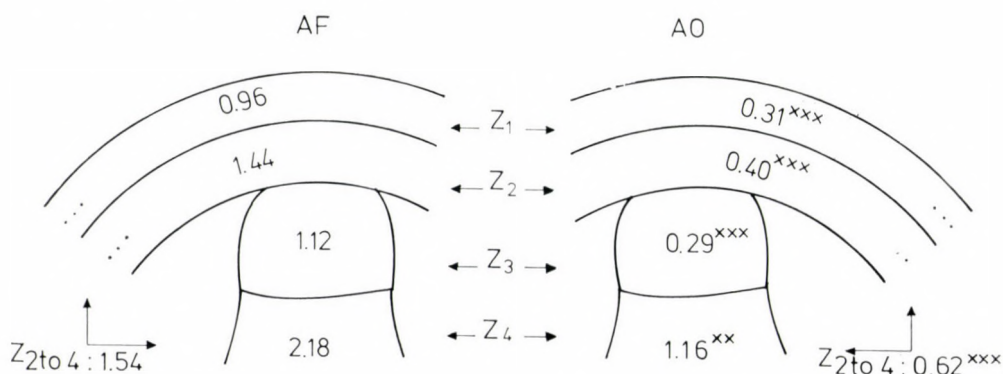
Fig. 6. Nucleohistone content in the apices of terminal buds of spurs bearing apple (AF) and without apple (AO)
staining: Fast Green FCF, values in arbitrary units; for testing significance see Fig. 1, Table 2 and 3 resp.

It should be mentioned that our cytochemical investigations were carried out in apices with histological organization typical for the vegetative stage, that is, before activation of the central meristem. In spite of the vegetative structure existing, the physiological floral induction must be completed as it is expressed by altered cytochemical characteristics (compare AO and AF buds, resp.). During the next developmental stage (histological differentiation within the apex) there are again other conditions with respect to nucleic acid level in various meristem zones (BUBÁN and SIMON 1978).

Data presented above are preliminary results, more detailed investigations are going on, currently. Nevertheless, our investigations conducted so far are able to make clear that a really higher nucleic acids level and a much lower nucleohistone content exist in the apices of terminal buds on spurs without fruit. On the other hand, data concerning nucleic acid — and nucleohistone content show a considerable uniformity within these apices. It seems worth stressing the fact that apices of these buds are practically induced for transition to the reproductive state. This induction should be related to the lack of endogenous growth substances (mainly gibberellins) originating from seedlets of young fruits (BUBÁN and SÁGI 1976).

From data it can be concluded that the situation demonstrated by quantitative cytophotometry has proved to be an essential precondition for flower bud differentiation.

REFERENCES

ALFERT, M.—GESCHWIND, J. (1953): A selective staining method of the basic proteins of cell nuclei. Proc. Nat. Acad. Sci. (USA), **39**, 991—999.
ARNOLD, M. (1968): Histochemie. SPRINGER Verlag, Berlin—Heidelberg—New York, 140.

BERNIER, G. (ed.), (1970): Cellular and molecular aspects of floral induction. LONGMAN, London, 492 pp.
BLOCH, D.—GODMAN, G. (1955): A microphotometric study of the synthesis of desoxyribonucleic acid and nuclear histone. J. biophys. biochem. Cytol. **1**, 17—28.
BUBÁN, T. (1970): Histologische und histochemische Untersuchung der Blütenknospendifferenzierung beim Apfel. in: Physiologische Probleme im Obstbau, Tgber. Dtsch. Akad. Landw. Wiss. **99**, 21—34.
BUBÁN, T.—HESEMANN, C. (1975): Cytochemical investigations of the shoot apex of apple trees. 2nd Symp. Plant Growth Reg.-s, Sofia, 21—24th Oct.
BUBÁN, T.—SÁGI, F. (1976): The mode of action of the chemicals regulating flower bud differentiation. Fruit Sci. Rep. **3**, 1—8.
BUBÁN, T.—SIMON, I. (1978): Cytochemical investigations in apices of apple buds with special respect to the flower initiation. Acta Horticult. **80**, 193—198.
FEUCHT, W.—ARANCIBIA, M. (1969): Zur lokalisierten Ca-Oxalatausscheidung im Knospengewebe des Apfelbaumes während der floralen Induktion. Arch. Gartenbau, **17**, 565—574.
GIFFORD, E. jr. (1963): Developmental studies of vegetative and floral meristems. Brookhaven Symp. Biol. **16**, 126—137.
GRAUMANN, W. (1953): Zur Standisierung des Schiffschen Reagens. Z. wiss. Mikr. **61**, 225—226.
HESEMANN, C.—BUBÁN, T. (1973): Methodik cytochemischer Analysen bei pflanzlichen Objekten. Histochem. **36**, 237—246.
KIEFER, G.—ZELLER, W.—SANDRITTER, W. (1969): Eine Methode zur histochemischen Bestimmung von RNS und DNS an der gleichen Zellen. Histochem. **20**, 1—10.
KNOX, R.—EVANS, L. (1966): Inflorescence initiation in Lolium temulentum L. — VIII. Histochemical changes at the shoot apex during induction. Aust. J. Biol. Sci. **19**, 233—245.
MITCHELL, J. (1968): Quantitative microspectrophotometry of RNA in plant tissue. Histochem. J. **1**, 106—123.
SACHS, R. (1977): Nutrient diversion: an hypothesis to explain the chemical control of flowering. Hort. Sci. **12**, 220—222.
SCHMIDT, S. (1977): Nukleinsäuremetabolismus und Blütenknospenentwicklung bei Apfel (Malus domestica). Manuscript.
ZEEVAART, J. (1962): DNA multiplication as a requirement for expression of floral stimulus in Pharbitis nil. Plant Physiol. **37**, 296—304.

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NICHE STUDIES ON SOME PLANT SPECIES OF A GRASSLAND COMMUNITY. IV

FESTUCA VAGINATA POPULATIONS' NICHE CHARACTERISTICS ON THE BASIS OF THE MACRO- AND MICROELEMENT CONTENT OF THE SOIL AND THE PLANT*

By

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The macro- and microelement content of *Festuca vaginata* individuals and of their soil collected from three swards in which *Festuca vaginata* are dominant (*Festucetum vaginatae*) was studied to determine where the niche width is the greatest in the soil, in the above-ground plant part and in the case of plant/soil. The elements examined were as follows: K, Ca, P, Mg, Na, Al, Fe, Mn and Zn. For the evaluation, the formulae B_i and $^*B_i$ (divided by the category number) and the D^2 analysis were applied. On the basis of plant/soil ratio some estimation was obtained with regard to the degree of efficiency with which the plant utilizes the nutrients available for it. Of the three populations, one was obtained from the characteristic sand dune soil of the region between the Danube and the Tisza (Fülöpháza), the other from an area lying near to the Central part of Hungarian Middle-Range (Neszmély), and the third from an area of transitory character (Vácrátót). The niche width of the population at Vácrátót, calculated on the basis of plant/soil, is the greatest on five niche axes. The niche widths of the population obtained from Fülöpháza narrow down owing probably to specialization. The niche widths of the population from Neszmély—supposedly as a result of competition among accompanying plants — are narrower than that from Vácrátót. The nutrient utilization of the three populations, on the basis of the result from D^2 analyses, is different. The plant activity and selectivity have a decided influence upon the nutrient utilization.

Introduction

Currently it is considered that adaptation and adaptive strategies (cf. STERN and ROCHE 1974) applied by races and ecotypes of identical species growing in different habitats, is taking place in the course of natural selection, moreover the characters differ by yield or other criteria, and sometimes even of with respect to background, as well as the state of physiological adaptation (ANTONOVICS, LOVETT and BRADSHAW 1966; GOODMAN 1969; etc.). It also seems probable that differences will be seen in the niche configuration of ecotypes or only of populations originating from different habitats; hardly any investigations of this kind have however, been carried out so far. Up to the present day, the concept of niche has only to a slight extent taken root in plant ecological works (cf. WHITTAKER and LEVIN 1975; the regeneration niche concept of GRUBB 1977; FEKETE et al. 1976; PRÉCSÉNYI et al. 1977a, 1977b).

* Tece studies №. 11

Material and Method

Owing to the relative simplicity of carrying out examinations is sandy meadows, we chose a similar habitat as before (FEKETE et al. 1976; PRÉCSÉNYI et al. 1977a, 1977b). Our object was *Festuca vaginata* which in dominant in that soil. We were concerned with what the environmental factors were to be considered, with respect to *Festuca* when describing the niche. Obviously, owing to the simple physiognomical structure of the meadow, no aerial ecological factors can be mentioned. In choosing the soil ecological factors, the nutrient content, seemed to be the most reasonable.

In the spring of 1977, we visited 3 *Festuca vaginata* habitats in Hungary. They were: Fülöpháza (F), in the region between the Danube and the Tisza, toward the west of the town of Kecskemét, in the sandy area of the Kiskunság; Neszmély (N) at the northern foot of the Hungarian Middle-Range in Transdanubia (Gerecse); and Vácrátót (V) also a sandy area of the Danube—Tisza region, but 110 km to the north of Fülöpháza (Fig. 1). Sampling times: 13. 4 Vácrátót; 5. 4 Fülöpháza; 15. 4 Neszmély. Samples were taken at all three sites from 10 Festuca vaginata tufts each. The above-ground parts of the plants were carefully cleaned (with cotton wool) of sand; samples were taken only from the above-ground parts. The slightly humic sandy soil was removed from the rhisosphere of each of the tufts; samples were taken also from the sand which was cleaned of the coarser organic matter deposits. Thus, taken together, we obtained 3×10 plant (specimens) and 3×10 soil samples related to the former.

The accompanying plants occuring in all the three habitats of *Festuca vaginata* dominant in sandy meadow associations (*Festucetum vaginatae*) were as follows: *Andropogon ischaemum*, *Cynodon dactylon*, *Euphorbia seguieriana*, *Onosma arenaria*, *Syrenia cana*, *Fumana procumbens*, *Plantago indica*, *Crepis rhoeadifolia*, *Erigeron canadense*. The species occuring in the meadow of Fülöpháza and of Vácrátót: *Kochia laniflora*, *Tribulus terrestris*, *Holoschoenus vulgaris*, *Polygonum patulum*, *Centaurea arenaria*, *Alkanna tinctoria*, *Achillea ochroleuca*, *Medicago minima*; the species occuring at Fülöpháza and at Neszmély as well: *Teucrium chamaedrys*, *Scabiosa ochroleuca*, *Stipa capillata*, *Gypsophila arenaria*, *Dianthus pontederae*, *Asparagus officinalis*. Species occuring only at Fülöpháza: *Helianthemum nummularium*, *Thymus marschallianus*, *Silene parviflora*, *Astragalus varius*, *Dianthus serotinus*, etc. Species occuring only at Vácrátót: *Equisetum ramosissimum*, *Corispermum nitidum*, etc.; only at Neszmély: *Dianthus arenarius*, *Seseli annuum*, *Cytisus austriacus*, etc.
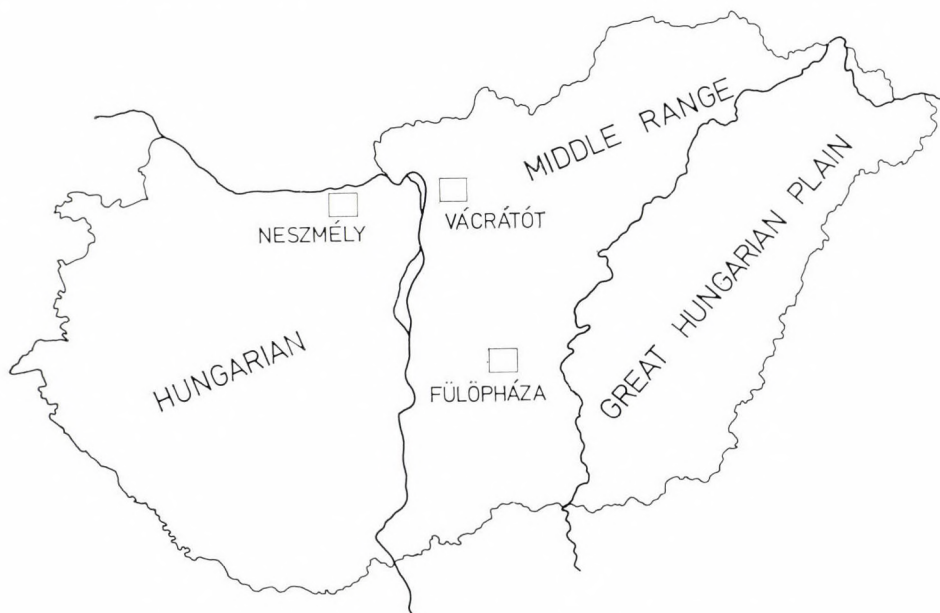
Fig. 1. Localities of the studied *Festuca vaginata* populations

Table 1

Macro- and trace element content in plants from population growing at Fülöpháza

	K	Ca	P	Mg	Na	Al	Fe	Mn	Zn
	g/kg					mg/kg			
1	10.5	2.4	1.3	0.6	0.036	98	231	43	24
2	10.5	3.8	1.4	0.9	0.036	94	328	60	31
3	13.5	3.3	2.2	0.6	0.028	56	211	63	25
4	13.5	3.4	1.9	0.7	0.032	49	196	51	29
5	10.0	3.3	1.6	0.7	0.044	66	198	71	26
6	10.0	2.7	1.2	0.6	0.036	43	162	59	17.6
7	13.0	2.8	1.5	0.5	0.058	67	201	51	32
8	7.0	3.2	1.1	0.6	0.032	40	195	51	28
9	8.5	2.8	1.4	0.5	0.024	8	159	40	16.4
10	11.5	3.1	1.7	0.6	0.024	85	225	46	33

Table 2

Macro- and trace element content in plants from population growing at Neszmély

	K	Ca	P	Mg	Na	Al	Fe	Mn	Zn
	g/kg					mg/kg			
1	7.5	5.0	0.9	0.8	0.052	680	895	35	45
2	4.0	4.3	0.6	0.6	0.044	490	910	24	43
3	5.0	3.5	0.7	0.5	0.036	500	940	26	38
4	4.0	3.9	0.6	0.5	0.048	850	875	30	46
5	3.8	4.0	0.6	0.6	0.048	553	783	23	39
6	4.5	6.1	0.6	0.9	0.056	680	890	35	35
7	5.0	5.7	0.7	1.0	0.060	1090	1250	43	39
8	4.7	5.9	0.7	0.8	0.052	846	1010	33	41
9	7.0	6.7	0.9	1.2	0.052	765	945	37	39
10	9.4	4.9	0.9	0.7	0.054	743	1000	30	33

The methods of the chemical analyses: Soil solutions were prepared with 0.1 normal hydrochloric acid; ratio of the solving agent: 1 : 10; time allowed for solving: 14—16 hours. The plant material was dried, than destroyed in a mixture of nitric acid and perchloric acid. The quantity of K, Ca, Mg, Na, Fe, Mn, and Zn contained in the residue was measured with a PERKIN—ELMER 290 B type atomabsorption spectrophotometer. The phosphorus content was determined with molibdate, and the aluminium content with eriochrome cyanide using the colorimetric method (TÖLGYESI 1969).

The basic data are given in Table 1—3 and 4—6.

In the evaluation, we applied the B_i niche widths $(1/\Sigma p_i^2)$ calculated after LEVINS (1968), or more exactly the $*B_i$-values (after division by the category number), and D^2 statistics were also applied.

Table 3

Macro- and trace element content in plants from population growing at Vácrátót

	K	Ca	P	Mg	Na	Al	Fe	Mn	Zn
	g/kg					mg/kg			
1	15.0	2.2	2.7	0.6	0.028	35	131	29	19
2	16.5	2.7	3.3	0.9	0.028	157	232	50	25
3	14.0	1.7	3.4	0.6	0.028	8	203	44	22
4	13.0	3.3	2.9	0.5	0.028	160	350	90	27
5	11.5	3.1	2.5	0.6	0.040	147	342	72	28
6	20.5	2.6	4.5	0.8	0.032	38	230	45	32
7	13.5	2.4	2.6	0.5	0.036	29	134	61	26
8	16.0	2.8	2.5	0.6	0.024	31	198	69	25
9	15.0	1.9	2.6	0.5	0.020	11	190	60	24
10	12.0	2.2	2.5	0.7	0.036	43	161	47	24

Table 4

Macro- and trace element content in soils of population of Festuca vaginata growing at Fülöpháza

	K	Ca	P	Mg	Na	Al	Fe	Mn	Zn
	mg/kg								
1	50	14 500	13.9	520	12.0	65	60.6	52	3.0
2	50	14 400	12.7	500	11.6	70	47.8	50	3.2
3	54	14.300	14.6	560	11.6	63	46.5	56	2.8
4	50	13 800	13.2	600	12.4	68	46.5	57	4.0
5	48	15 000	12.2	600	12.0	81	45.0	55	3.2
6	60	14 800	8.8	540	11.6	71	35.3	53	2.0
7	90	13 700	12.6	540	12.4	83	52.2	48	4.0
8	42	13 200	13.2	460	10.4	75	49.3	47	2.4
9	54	13 000	10.5	420	11.6	102	52.2	50	2.4
10	44	13 000	11.9	480	12.4	61	45.0	52	3.8

The measured 5 macroelements and 4 microelements together can be considered as a 9-dimensional niche space. It should be pointed out that not only the concentration values of the factors in the soil at the time of appearance of the plant, should be considered but also the quantity of elements accumulated by the plant. It follows that we compare the concentration values found in the plant with that occuring in the soil. By means of this, the niche acquires a functional sense, since we obtain a certain estimation of how the plant economizes with the nutrient element available for it. Although the authors are aware of the fact that from their data (few cases, and an unknown initial element concentration in the soil) only very cautious estimation can be made in relation to the nutrient utilization, they suggest that the plant/soil ratio expressing the utilization, or the efficiency, can be considered as a niche axis.

Table 5

Macro- and trace element content in soils of population of Festuca vaginata growing at Neszmély

	K	Ca	P	Mg	Na	Al	Fe	Mn	Zn
	mg/kg								
1	86	13 900	29.6	1020	20.0	243	25.3	63	8.0
2	53	12 000	23.3	940	17.6	204	26.7	54	4.6
3	53	11 700	24.8	860	21.2	216	21.1	49	5.0
4	62	13 400	21.8	930	15.6	188	16.9	54	4.2
5	59	11 900	25.8	1060	17.6	274	18.3	57	6.0
6	75	9 700	21.6	1120	16.4	216	21.1	60	5.2
4	75	9 000	31.6	1100	17.2	275	22.5	59	5.8
8	66	12 500	27.6	1100	18.4	199	39.5	63	5.2
9	66	13 100	24.1	1060	16.4	196	19.7	60	4.4
10	80	11 200	28.0	880	14.0	196	31.0	49	5.4

Table 6

Macro- and trace element content in soils of population of Festuca vaginata growing at Vácrátót

	K	Ca	P	Mg	Na	Al	Fe	Mn	Zn
	mg/kg								
1	51	1500	56.8	150	27.2	235	9.8	33	3.2
2	35	1000	69.5	172	11.6	272	11.3	29	2.4
3	40	1100	46.8	166	14.0	201	7.0	28	2.2
5	39	1500	53.7	186	10.8	238	14.1	29	3.0
5	36	1300	54.4	192	8.8	248	18.3	29	3.0
6	75	1000	49.3	190	10.0	265	14.1	27	3.0
5	42	1300	58.1	212	10.8	250	12.7	27	2.4
8	35	1000	54.4	178	9.6	235	16.9	27	2.6
9	44	1400	53.5	186	10.0	228	14.1	24	2.0
10	59	1200	65.0	198	10.8	217	21.1	26	2.6

Results and Discussion

Nutrient supply, nutrient content, ion-antagonism

As regards the calcium supply of the soil, the sample of Vácrátót is weaker with one order of magnitude than that of the other two; the calcium content of the plants at Vácrátót is also the lowest (the same has been experienced in acidic sand with *Festuca vaginata;* KÁRPÁTI I., KÁRPÁTI V. and TÖLGYESI 1970), while at the same time the plant/soil ratio is higher with a half order of magnitude which indicates that calcium utilization is more intensive here than it

Table 7

Means of concentrations and standard deviation of macro- and trace elements in Festuca vaginata

	Fülöpháza		Neszmély		Vácrátót	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
K	10.80	2.1370	5.49	1.8556	14.70	2.6059
Ca	3.08	.4077	5.00	1.0729	2.49	.5087
P	1.53	.3335	.72	.1315	2.95	.6364
Mg	.63	.1158	.76	.2269	.63	.1338
Na	.035	.0001	.05	.0067	.03	.0063
Al	60.60	27.5608	719.70	58.1777	65.90	62.3029
Fe	210.60	47.3033	949.80	39.1526	217.10	76.3142
Mn	53.50	9.6405	31.60	6.2570	56.70	17.4103
Zn	26.10	5.8583	39.80	4.1037	25.20	3.4900

Table 8

Means of concentrations and standard deviation of macro- and trace elements in soil

	Fülöpháza		Neszmély		Vácrátót	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
K	54.20	13.5794	67.50	11.2472	45.60	12.8254
Ca	13 970.00	118.1948	11 840.00	1556.4918	1230.00	200.2776
P	12.36	3.5157	25.82	3.3317	56.15	6.7845
Mg	522.00	22.8473	1 007.00	96.6149	183.00	17.4419
Na	11.80	3.4351	17.44	2.0833	12.36	5.3981
Al	73.90	12.2332	220.70	32.2664	238.90	21.2104
Fe	48.04	6.4939	24.21	6.8169	13.94	4.1219
Mn	52.00	3.3332	56.80	5.1595	27.90	2.3770
Zn	3.08	0.7000	5.38	1.0863	2.64	.4000

is the other two samples. As against this, the phosphorus content of the plants at Vácrátót is the highest. The phosphorus content of the mostly calcareous soil of Fülöpháza is the lowest, while at the same time there the plant/soil ratio is the highest, which may indicate an intensive phosphorus accumulation (Tables 7—9).

Considering the potassium content, the three samples show 2—3-fold deviations; thus, essential differences may occur not only within sub-species (cf. SHEA et al. 1968), but also among populations. The K/Ca ratio is the highest in the plant from Vácrátót, that is where calcium is less dominant in the soil. The population of Neszmély, is not able, in the course of taking up ions, to compensate the high calcium content of the soil by potassium; the K/Ca ratio is merely around 1 here. The population of Fülöpháza has more calcium ion and less potassium available than has the Neszmély population; in spite of this, the antagonism of the two ions is more favourable than in the case of the Neszmély population.

Table 9

Means and standard deviation of ratios of macro- and trace elements. Plant/soil

	Fülöpháza		Neszmély		Vácrátót	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
K	204.400	45.1595	80.400	19.7269	336.10	79.5982
Ca	.219	.0316	.433	.1257	2.07	.5338
P	124.420	22.4929	27.960	4.4697	53.67	16.0078
Mg	1.210	.2311	.747	.1803	3.48	.8514
Na	2.690	.8029	2.936	.6094	2.69	.9644
Al	.868	.4401	3.310	.8898	.26	.2445
Fe	4.425	1.0110	41.220	9.3429	16.61	6.6856
Mn	1.025	.1676	.555	.0927	1.97	.6550
Zn	8.543	1.3670	7.63	1.6594	9.70	1.6023

Table 10

Means of ion-ratios in three Festuca vaginata populations

	F	N	V
K/Ca	3.55	1.12	6.14
Ca/Mg	4.95	6.87	4.09
Fe/Mn	3.94	30.06	3.83

The calcium/magnesium ratio does not show much difference. The values of magnesium and sodium in the three samples are nearly identical.

The very high values of aluminium and iron contents in the population from Neszmély are not to be interpreted as the influence of the habitat but as the characteristics of the population. The high iron content in our case is not accompanied by low phosphorus and calcium values. On the other hand, the iron antagonism is recognizable also with samples from Neszmély (Table 10).

The regularity of the nutrient utilization

It is a fundamental question whether it is the plant or the soil that, in addition to several other factors regulates the nutrient utilization ratio (plant/soil). However simple the question is, it is difficult to answer it exactly. Since, on the basis of available data, it cannot be approached in any other way, we examine with what values the efficiency values are more consistent: with the value of the mentioned element (nutrient) shown from the plant as the value which expresses the "activity" and "selectivity" of the plant in this dimension — or with the values measurable in the soil — which on the other hand is a more passive factor and which indicates at the most the possibility of uptake only.

Table 11

Plant/soil—plant (1) and plant/soil—soil (2) relationships. Table of coefficients of correlation (r)

	Fülöpháza		Neszmély		Vácrátót	
	1	2	1	2	1	2
K	.555	—.515	.860**	.203	.241	—.700*
Ca	.924***	—.328	.839**	—.701*	.738*	—.624
P	.742*	—.241	.745*	—.211	.925***	—.648*
Mg	.820**	—.314	.965***	.466	.923***	—.541
Na	.984***	.094	.864**	—.875***	.778**	—.706*
Al	.976***	—.750*	—.832**	—.428	.996***	.459
Fe	.840**	—.350	.225	—.834**	.587	—.578
Mn	.930***	.054	.889***	.123	.357	—.465
Zn	.353	—.271	.510	—.783**	.501	—.726*

* significant at 5%
** significant at 1%
*** significant at 0.1%

The result is very instructive; can read decidedly from the Table 11 the outstanding influence of the plant. There is a positive and in many cases significant relationship between the plant (ion content) and the the nutrient efficiency. As against this, the correlations between efficiency and the nutrient values of the soil in most cases are negative; at least, the significant correlations are all negative. This fact in itself shows how unsatisfactory it is if only the environment is examined and its values only are considered, or how essential it is to measure also the plant's response. From the Table we can realize that the differences in the populations arise primarily in the case of the micro-nutrient supplies, while in the case of the macro-nutrient elements (with the exceptional potassium) there is great agreement among the three samples.

Niche width

Table 12 presents the $*B_i$-values by calculating in three different ways. It is more traditional to calculate it on the basis of the nutrient concentration in the soil, while it is a more modern way to obtain the representation of the niche widths by the plant/soil values. It can be seen that the absolute values are entirely different, and also the orders by elements, in the three modes of calculation. For example, on the basis of the plant, the samples of Vácrátót stand only once at the first place of the $*B_i$ rank—in the case of Mn—but since on the basis of the soil the width is rather narrowed down, if our calculation is based on plant/soil ratio, the samples can be placed first even on 5 axes. Accordingly, it cannot be considered a specialist in any of the axes. The soil representation of the samples of Neszmély varies within wide limits; it is of the greatest width with 7 ions; that this in this way is unrealistic is indicated even by the plant/soil values; it seems that Festuca becomes the specialist of magnesium and manganese. The population from Fülöpháza is a specialist one in respect of the calcium and iron-content, and as against the other two populations it is not general in any of the axes.

Table 12

Niche breadth (B_i)-values calculated on the basis of data of plant, soil, and plant/soil*

	Plant				Soil				Plant/Soil			
	F	N	V	number of categories	F	N	V	number of categories	F	N	V	number of categories
K	.3704	.3268	.3704	9	.2688	.5208	.2976	12	.3030	.1337	.4545	11
Ca	.2525	.5682	.3496	11	.1701	.2747	.0714	14	.0714	.1879	.4464	14
P	.2645	.1111	.2057	9	.0938	.1832	.2747	13	.3571	.1231	.1786	15
Mg	.3676	.7812	.4464	8	.1923	.2273	.0610	20	.1333	.1149	.4762	15
Na	.6250	.4464	.4807	8	.2000	.2941	.2381	10	.3030	.3333	.4166	15
Al	.0909	.5050	.1683	11	.1317	.3030	.3247	11	.2976	.4166	.1437	12
Fe	.1984	.3472	.2193	12	.1984	.3472	.2451	12	.0714	.5102	.3571	14
Mn	.4166	.2717	.5682	8	.2976	.3247	.1323	14	.1984	.1231	.5102	14
Zn	.4762	.4202	.3086	7	.3205	.3205	.2137	13	.3247	.3968	.3571	14

D^2-analysis

By means of the D^2-analysis it can be established suitably how the point clouds of distribution in five dimensions (macroelements) and in four dimensions (trace elements) cover each other, or how they diverge from one another (cf. SHUGART and PATTEN 1972; FEKETE et al. 1976, PRÉCSÉNYI et al. 1977a). The results of D^2-analyses are shown in Tables 13, 14 and 15.

Table 13

D^2-analysis result. D-values, Festuca vaginata

	Macroelements		Trace elements	
	Fülöpháza	Neszmély	Fülöpháza	Neszmély
Neszmély	2.3153***		4.5003***	
Vácrátót	1.2558**	1.9491***	0.1241NS	18.468***

NS = not significant; marks see in Table 11.

Table 14

D^2-analysis result. D-values. Soil

	Macroelements		Trace elements	
	Fülöpháza	Neszmély	Fülöpháza	Neszmély
Neszmély	2.5771***		2.3469***	
Vácrátót	8.3384***	5.9867***	6.1098***	2.7877***

marks see in Table 11.

Table 15

D^2-analysis result. D-values. Plant/soil

	Macroelements		Trace elements	
	Fülöpháza	Neszmély	Fülöpháza	Neszmély
Neszmély	2.7694***		3.1318***	
Vácrátót	2.2654***	2.0260***	1.4135**	2.2643***

Marks see in Table 11.

Table 14 presents the complete separation of *Festuca vaginata* soils by sample pairs. The two samples of the Duna—Tisza region (the values measured in the plant) on the other hand do not separate as regards the trace elements. In the plant/soil values the separation is already complete in the case of all three sample pairs, in both the macro- and trace elements.

Summary

Samples were collected from *Festuca vaginata* populations growing in different conditions both geographically — they were obtained from 3 areas — and to a certain extent cenologically. The habitat of Fülöpháza is the most extreme (the sward is the most open); the habitat of Neszmély, with its greatest closeness, has an inclination towards the steppe-meadows in the Middle-Range; the habitat in Vácrátót occupies a medium place.

Ten tufts were collected from each of the habitats, together with soil; they were determined for 9 elements.

As regards the macroelements in the samples, potassium and phosphorus show the most essential deviation. The very high value of aluminium and iron in the plants from Neszmély can probably be explained as a characteristic of the population. This population is remarkable with its high Fe/Mn ratio and its low K/Ca ratio.

For the characterization of the niche (niche width, niche separation) is reasonable if we take the plant/soil nutrient ratios into consideration; such axes can indicate the utilization (efficiency).

The niche widths of the population originating from Fülöpháza, which is of an extreme position, pushed forward towards the edafical sand desert may — owing to specialization — decrease.

The niche widths of the population of Neszmély, which protrudes towards the Middle-Range tend to decrease too — probably owing to the growing competition of the accompanying plants. The niche widths of the population from Vácrátót, which is of a transitory position, are the greatest even on 5 axes.

On the basis of the values by rank order of the niche widths, in the case of plants and soils, of the three population that of Neszmély showed the

greatest width, then come the populations of Vácrátót and of Fülöpháza. In the case of plant/soil, the sample from Vácrátót stands at the first place, and it is followed by samples from Neszmély and then from Fülöpháza.

As regards the nutrient utilization, we succeeded in detecting the differences in the 3 samples — by means of D^2 analysis.

In our case, it is not the soil which is responsible for the values of nutrient utilization, since the values measured in the soil are at most only indicators of the possibilities of uptake. The plant, by its activity and selectivity, decidedly influences the efficiency.

REFERENCES

ANTONOVICS, J.—LOVETT, J.—BRADSHAW, A. D. (1966): The evolution of adaptation to nutritional factors of herbage plants. In: The use of isotopes in plant nutrition and physiology, IAEA, Wien

FEKETE, G.—PRÉCSÉNYI, I.—MOLNÁR, E.—MELKÓ, E. (1976): Niche studies on some plant species of a grassland community I. Comparison of various measurements. Acta Bot. Acad. Sci. Hung. **22,** 321—354.

GOODMAN, P. J. (1969): Intra-specific variation in mineral nutrition of plants from different habitats. In: RORISON, I. H. (ed.): Ecological aspects of the mineral nutrition of plants, p. 237—253. Blackwell.

GRUBB, P. J. (1977): The maintenance of species richness in plant communities: the importance of the regeneration niche. Biol. Rev. (Cambridge) **52,** 107—145.

KÁRPÁTI, I.—KÁRPÁTI, V.—TÖLGYESI, GY. (1970): Concentration changes of some chemical elements in the plant species of acidophil and calcareous sand steppe swards. Acta Bot. Acad. Sci. Hung. **16,** 299—311.

PRÉCSÉNYI, I.—FEKETE, G.—MELKÓ, E.—MOLNÁR, E. (1977a): Niche studies on some plant species of a grassland community II. Seasonal niche dynamic. Acta Bot. Acad. Sci. Hung. **23,** 193—218.

PRÉCSÉNYI, I.—FEKETE, G.—MELKÓ, E.—MOLNÁR, E. (1977b): Niche studies on some plant species of a grassland community III. Overlap investigations by cluster analysis. Acta Bot. Acad. Sci. Hung. **23,** 367—374.

SHEA, P. F.—GERLOFF, G. C.—GABELMAN, W. H. (1968): Differing efficiencies of potassium utilization in strains of snapbeans, Phaseolus vulgaris L. Plant and Soil **28,** 337—357.

SHUGART, H. H. jr.—PATTEN, B. C. (1972): Niche quantification and the concept of niche pattern. In: PATTEN, B. C. (ed.): Systems analysis and simulation in ecology, Vol. II. Acad. Press, New York, 283—327.

STERN, K. S.—ROCHE, L. (1974): Genetics of forest ecosystems. Ecological studies. Vol. **6,** pp. 330. Springer.

TÖLGYESI, GY. (1969): Microelement-content of plants and its agricultural importance (in Hungarian language). Mezőgazdasági Kiadó, Budapest.

WHITTAKER, R. H.—LEVIN, S. A. (eds., 1975): Niche. Theory and application. Benchmark paper in ecology. Vol. **3,** pp. 448. Dowden, Hutchinson and Ross, Inc., Stroudsburg.

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SCANNING ELECTRON MICROSCOPY OF SOME SELECTED RECENT AMENTIFLORAE POLLENS I

By

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A new series of papers, on the scanning electron microscopy of some *Amentiflorae* taxa is begun. In this paper (in the first part of this series) with the following genera are dealt: *Corylus*, *Carpinus*, *Ostrya*, *Casuarina*.

Introduction

Concerning the light microscopy of the recent *Amentiflorae* pollens we have a number of publications. The most important data was summarized by THANIKAIMONI (1973, 1976). During our TEM and SEM investigations on *Normapolles* taxa (STANLEY and KEDVES 1975) we needed to make some SEM observations on recent *Carya* species (KEDVES and STANLEY 1976). In contrast with the fact, that we have much information about the recent fossil *Amentiflorae* taxa, there are few SEM data, so it is important to continute SEM investigations in this field of Palynology.

Material and Method

The investigation material was collected in the Herbarium of the Museum of Natural History, Budapest for which I express my sincere thanks to Dr. J. SZUJKÓ-LACZA, head of the Botanical Department. For the preparation of the air dried pollen material, the LEFFINGWELL's method was taken for a basis (1970, in LEFFINGWELL, LARSON and VALENCIA). After the covering (with gold-palladium) the stubs were oriented in 45° as usually. The SEM pictures were taken in the EM Laboratory of the Hungarian Academy of Sciences (Dept. of Zoology, ELTE University, Budapest). Thanks, for Associated Professor J. KOVÁCS, Associated Professor M. JÁRAI-KOMLÓDI (Dept. of Systematic Botany, and Phytoecology of the ELTE University, Budapest). For adhesive material, Methyl-ethyl-ketone contain polyvinylchloride was used. This adhesive material was obtained from Dr. H. LEFFINGWELL (Anaheim, California, USA) many thanks for his generous help.

The diameter data of the pollens are based on 150—200 measurements of pollen, the SEM characters are of 2 or 3 specimens.

Results

In this paper we publish the SEM results of the following genera: 1. *Corylus*, 2. *Carpinus*, 3. *Ostrya*, 4. *Casuarina*.

1. General characters of the pollen grains of the above mentioned genera:

1.1. Light microscopically these pollens are triaperturate, apertures sometimes prominent, amb in polar view triangular or semicircular. Based on the classical light microscopical results, all pollens of these genera have pores (no atrium, no vestibulum).

1.2. The most important TEM data are as follows:

The infratectum is granular, like many Upper Cretaceous and Lower Tertiary *Normapolles*. This seems to be one of the characters of the recent *Amentiflorae* taxa. Tectum with spines: *Corylus*, *Carpinus*, *Ostrya*, *Casuarina*. Channels in the tectum: *Corylus*, *Carpinus*, *Ostrya*.

Lamellar endexine in the pore wall region: *Corylus*, *Carpinus*.

Other kind of endexine: *Casuarina*.

Pores, by the TEM data: *Corylus*.

Table 1

Species	Coni basis	No. coni per μ^2	Stries	Diameter, μ	Prominent germ.
Corylus					
C. americana	0.2	3	+	18—26	±
C. avellana	0.25—0.3	2—3	±	26—34	±
C. colurna	0.2	2—3	—	18—26	—
C. heterophylla	0.2	3—4	—	16—18	—
C. maxima	0.15—0.2	6	—	18—24	—
C. mirabilis	0.25	4—5	—	22—26	—
C. rostrata	0.2—0.25	3—4	—	24—30	—
C. yunnanensis	0.3	2—3	—	28—35	—
Ostrya					
O. carpinifolia	0.2	3—4	±	20—28	+
O. virginica	0.25	3	±	25—30	+
Carpinus					
C. americana	0.25	1—2	+	30—35	±
C. betulus	0.2	2—3	+	38—46	+
C. caroliniana	0.2	3	±	38—46	+
C. cordata	0.2	3	+	38—45	+
C. duinensis	0.2	3	±	28—35	+
C. orientalis	0.2	2—3	±	34—40	+
Casuarina					
C. equisetifolia	0.4	2	+	28—37	±
C. glauca	0.2	3—4	+	25—30	+
C. stricta	0.3	2—3	—	27—38	—

Other kinds of aperture (atrium) based on the TEM data: *Carpinus, Ostrya, Casuarina.*

1.3. The submicroscopical sculpture have two types:

1.3.1. Coni

On Eocene fossil Normapolles STANLEY and KEDVES (1975) investigated this type of submicroscopical sculpture.

1.3.2. Stries

The most important palynological characters of the investigated species are summarized in the Table 1.

Under the Scanning effect we observed many deformed pollen grains. We concluded, that these are connected with the ontogenetical stage of the pollen grains.

REFERENCES

KEDVES, M.—HEGEDÜS, M.—PÁRDUTZ, Á. (1971): Ultrastructure investigations on the exine of the genus Casuarina L. (Short communication.) Acta Biol. Szeged **17,** 63—65.

KEDVES, M.—PÁRDUTZ, Á. (1973): Ultrastructural studies on Amentiflorae pollen grains I. Acta Biol. Szeged **19,** 19—32.

KEDVES, M.—PÁRDUTZ, Á. (1974): Ultrastructural studies on Amentiflorae pollen grains II. Acta Biol. Szeged **20,** 69—80.

KEDVES, M.—STANLEY, E. A. (1975): Electronmicroscopical investigations of the Normapolles group and some other selected European and North American Angiosperm pollen II. Pollen et Spores **18,** 105—127.

LEFFINGWELL, H. A.—LARSON, D. A.—VALENCIA, M. J. (1970): A study of the fossil pollen Wodehouseia spinata. I. Ultrastructure and comparisons to selected modern taxa. II. Optical microscopic recognition of foot layers in differentially stained fossil pollen and their significance. Bull. of Canad. Petroleum Geology **18,** 238—262.

STANLEY, E. A.—KEDVES, M. (1975): Electronmicroscopical investigations of the Normapolles group and some other selected European and North American Angiosperm pollen I.

THANIKAIMONI, G. (1973): Index bibliographique sur la morphologie des pollens d'Angiospermes. Supplément-1, Inst. fr. Pondichéry, Trav. Sect. sci. tech. **12,** 1—164.

THANIKAIMONI, G. (1976): Index bibliographique sur la morphologie des pollens d'Angiospermes. Supplément-2, Inst. fr. Pondichéry, Trav. Sect. sci. tech. **13,** 1—386.
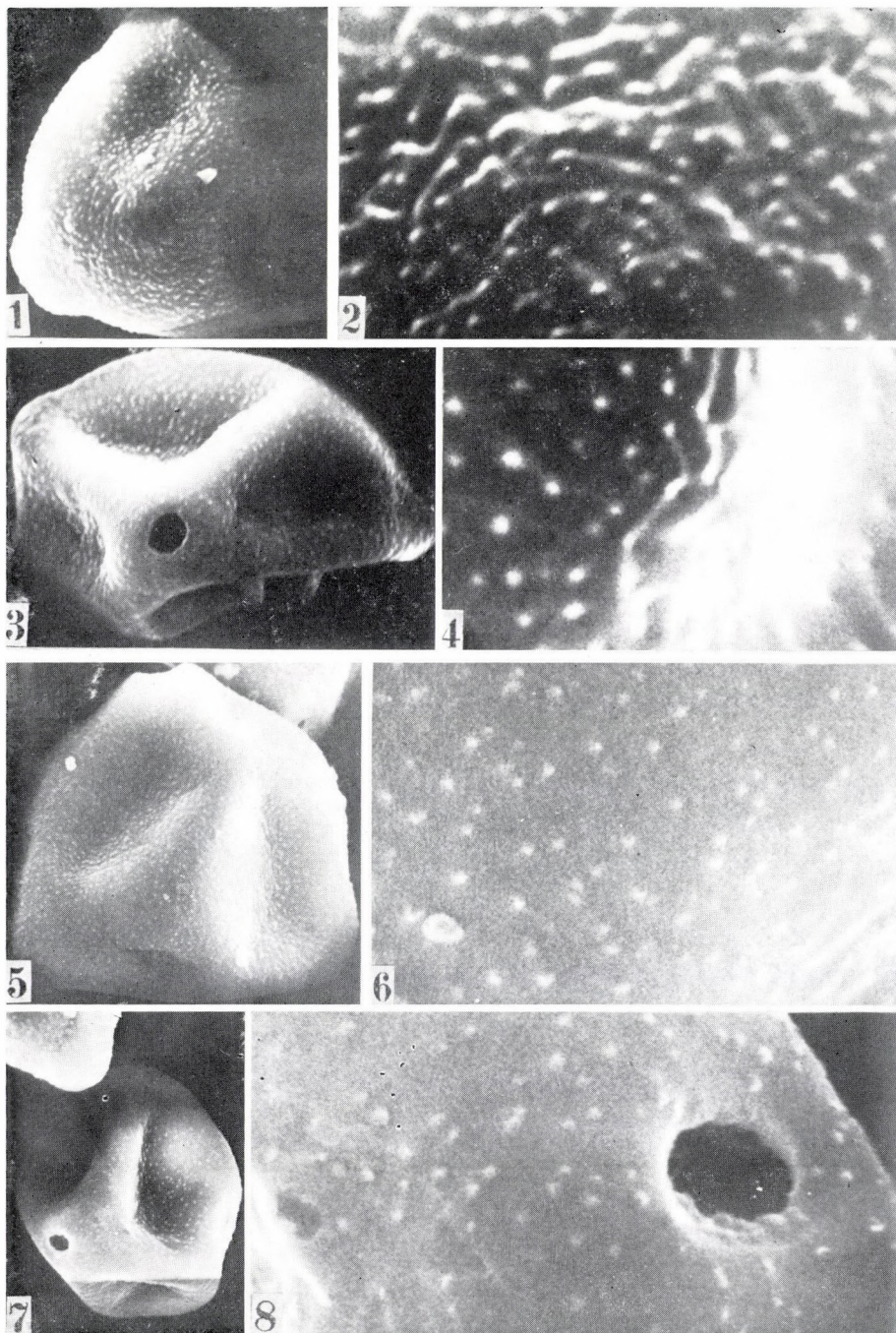
Plate I

1. *Corylus americana* Walt. ×2000
2. *Corylus americana* Walt. ×10000
3. *Corylus avellana* L. ×2000
4. *Corylus avellana* L. ×10000
5. *Corylus colurna* L. ×2000
6. *Corylus colurna* L. ×10000
7. *Corylus heterophylla* Fischer ×2000
8. *Corylus heterophylla* Fischer ×10000
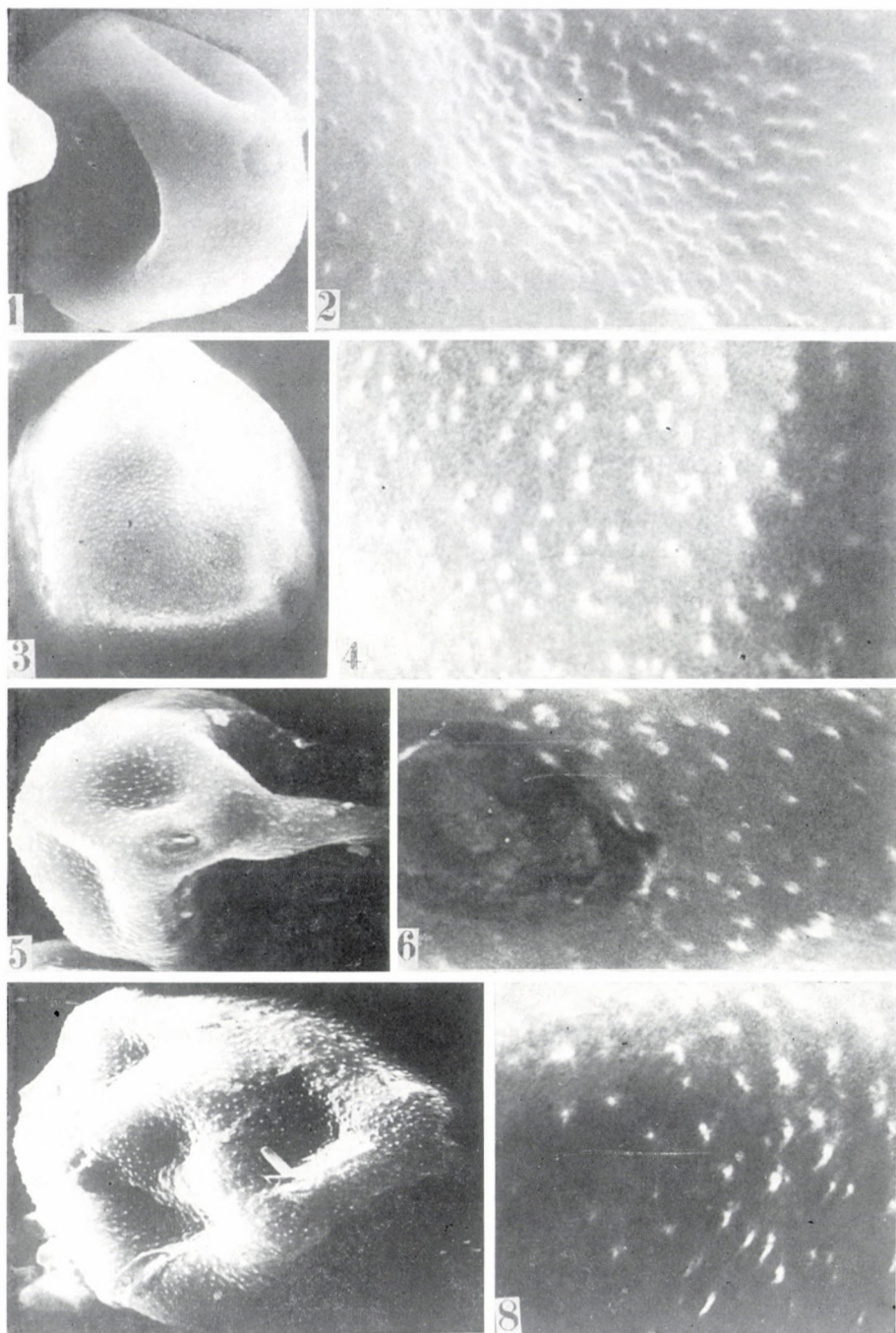
Plate II

1. *Corylus maxima* Mill. ×2000
2. *Corylus maxima* Mill. ×10000
3. *Corylus mirabilis* Sennen ×2000
4. *Corylus mirabilis* Sennen ×10000
5. *Corylus rostrata* Aiton ×2000
6. *Corylus rostrata* Aiton ×10000
7. *Corylus yunnanensis* A. Camus ×2000
8. *Corylus yunnanensis* A. Camus ×10000
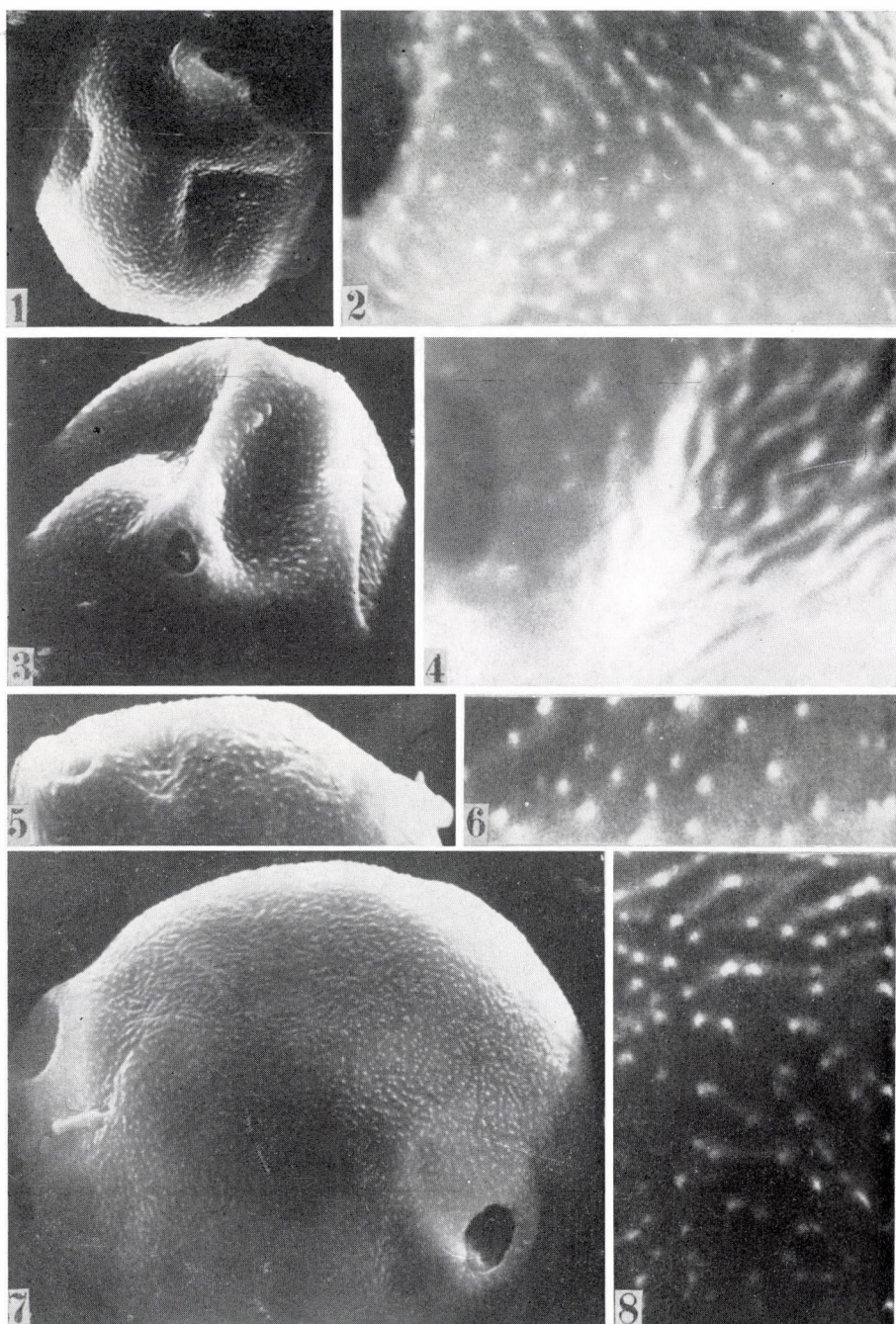
Plate III

1. *Ostrya carpinifolia* Scop. ×2000
2. *Ostrya carpinifolia* Scop. ×10000
3. *Ostrya virginica* Willd. ×2000
4. *Ostrya virginica* Willd. ×10000
5. *Carpinus americana* L. ×2000
6. *Carpinus americana* L. ×10000
7. *Carpinus betulus* L. ×2000
8. *Carpinus betulus* L. ×10000
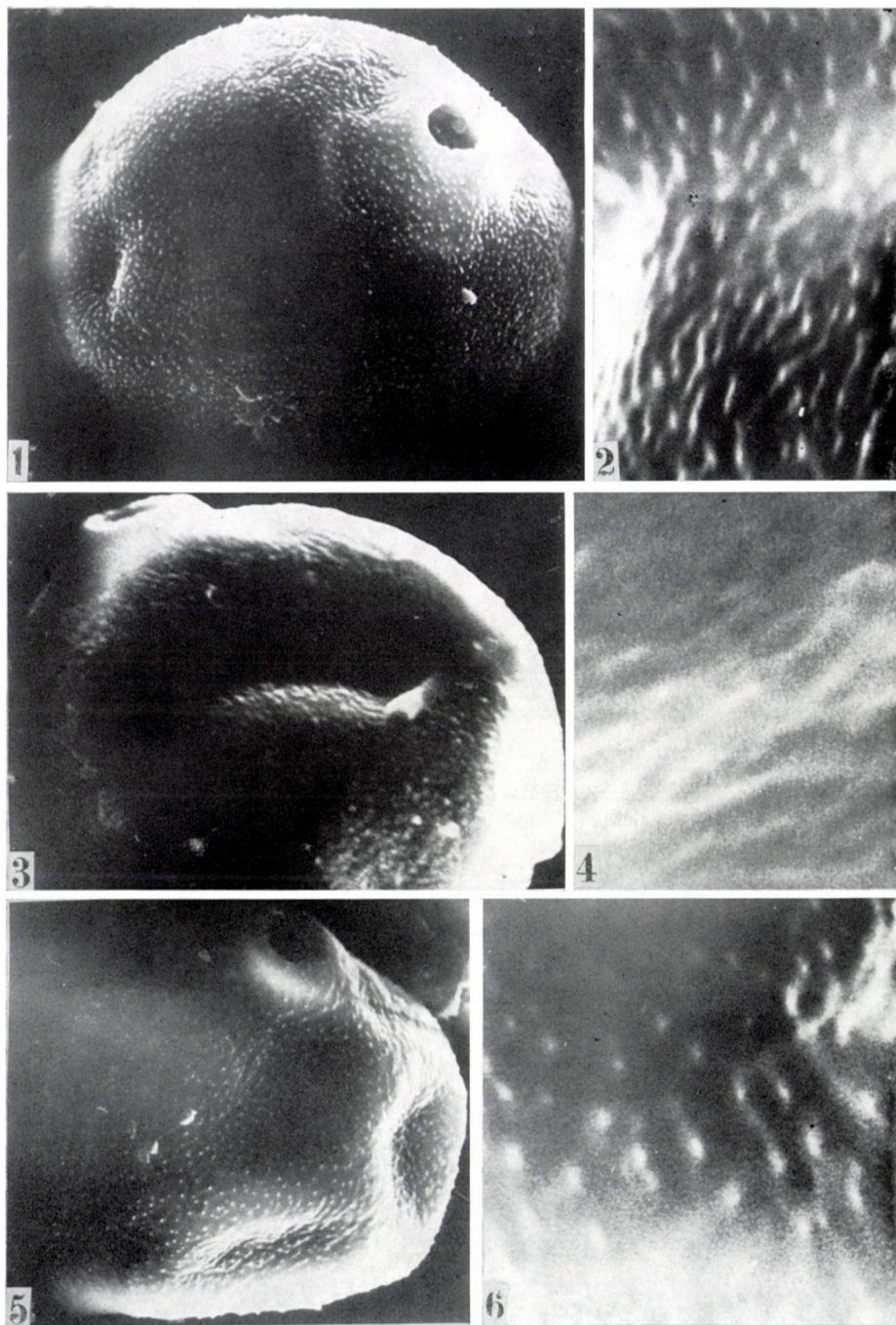
Plate IV

1. *Carpinus caroliniana* Walt. ×2000
2. *Carpinus caroliniana* Walt. ×10000
3. *Carpinus cordata* Blume ×2000
4. *Carpinus cordata* Blume ×10000
5. *Carpinus duinensis* Scop. ×2000
6. *Carpinus duinensis* Scop. ×10000
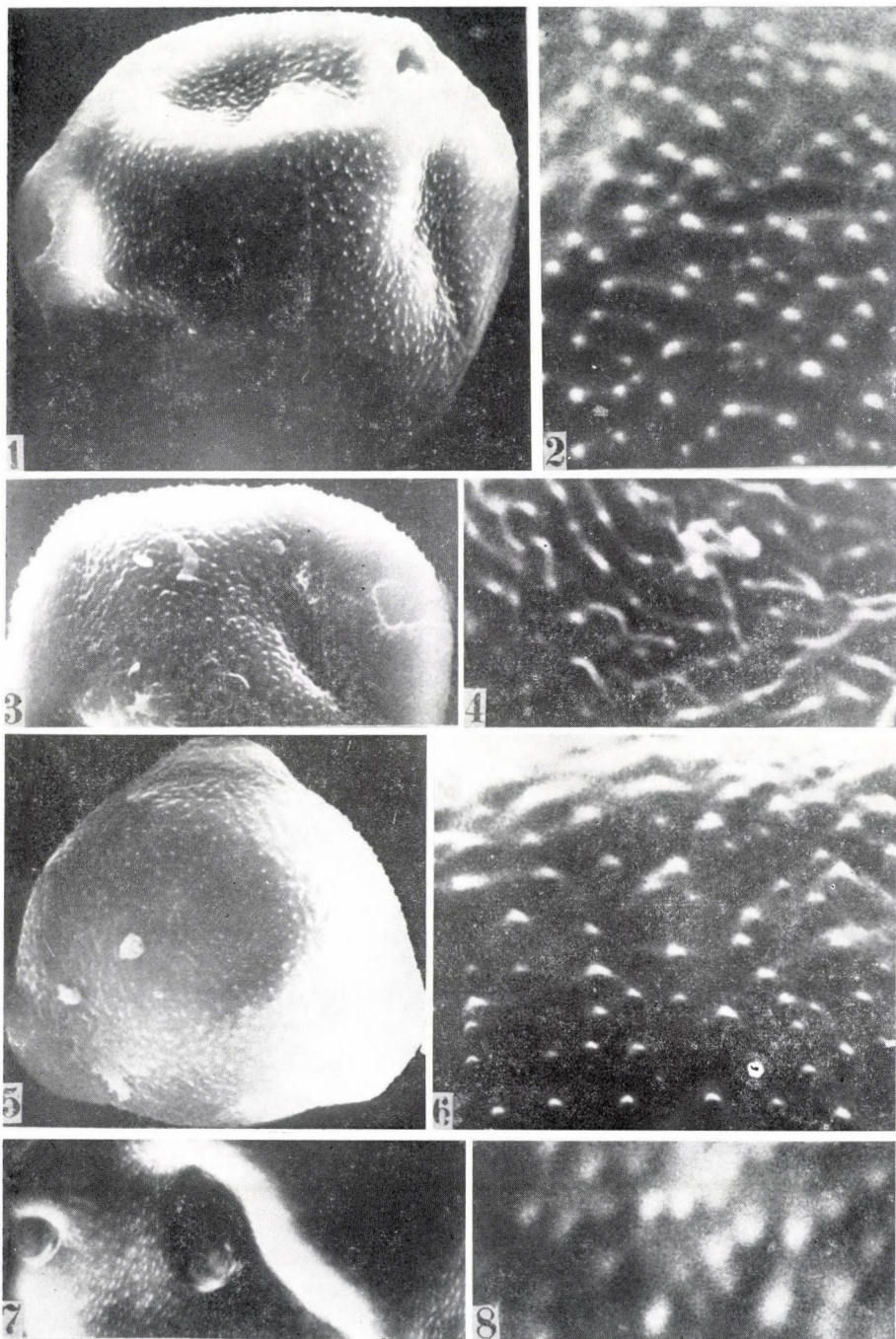
Plate V

1. *Carpinus orientalis* Mill. ×2000
2. *Carpinus orientalis* Mill. ×10000
3. *Casuarina equisetifolia* L. ×2000
4. *Casuarina equisetifolia* L. ×10000
5. *Casuarina glauca* Sieb. ×2000
6. *Casuarina glauca* Sieb. ×10000
7. *Casuarina stricta* (Dryand) Ait. ×2000
8. *Casuarina stricta* (Dryand) Ait. ×10000

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STUDY OF THE FLOWERING AND GENERATIVITY OF ADONIS VERNALIS L. POPULATIONS

By

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The study of flowering and generativity of *Adonis vernalis* L. plant individuals has led to the following conclusions: The *Indexes*-V and -G (expressing the flowering and generativity of plant individuals) are also suitable for the featuring of populations. Using them, it can be determined when the majority of plants are in the phenophase of full-flowering. This is the phenophase of mass flowering of the population. The rightwards slanting curve of the distribution of Index-G frequencies does not fit to that of the normal frequency distribution. G-index values of plant individuals within one population have also a rightwards slanting curve of frequency distribution. The analyses of the phenophase of flowering as a function of generativity resulted in the conclusion that within a population the flowering process of highly generative plants is protracted.

Introduction

In an earlier paper (MÁTHÉ 1977), we reported on the elaboration of the *Index of Flowering* (V) and *Index of Generativity* (G) for the ecological study of *Adonis vernalis* L.

The *Index of Flowering* (V) is calculated for the numerical expression of the phenophase of flowering of the species. For this purpose, we made use of the flowering characteristic of the plants, according to which, buds, flowers and fruits (in the phenophase of fruit-setting) can be found on the same plant, at a given time. In the phenophase of full flowering, the number of buds and fruits is equal and the frequency of flowers is highest.

The *Index of Generativity* (G) has its theoretical foundation in the plant community living under favourable ecological conditions. It is known that these plant communities are to be characterised by epharmose and the highest reproductivity of their species. Therefore, it may well be surmised that the numerical expression of the generativity of their plant individuals at a given time, could give ground for the comparison of different populations or habitats. This presumption is verified by POSHKURLAT (1971), according to whom the generativity of *Adonis vernalis* L. populations in the European territory of the Soviet Union and Siberia is different.

In our paper using the two Indexes we aimed at the further study of *Adonis vernalis* L. populations.

Material and Method

The morphological analyses of *Adonis vernalis* L. populations were carried out in 1976—77. In the course of these investigations the number of generative organs (bud, flower, fruit) and that of the shoots without generative formula (vegetative shoots) was recorded. The plant individuals to be measured were selected at random.

To characterise the flowering and generativity of the plants, we used the Indexes-V and -G. They are calculated as follows:

$$Index\text{-}V = \frac{t - b}{b + v + t}$$

$$Index\text{-}G = \frac{b + v + t}{number\ of\ vegetative\ shoots}$$

b = number of buds; v = number of flowers; t = number of fruits (in fruit-setting).
Further details on the Indexes are given by MÁTHÉ (1977).

Results and Evaluation

In the course of our investigations we were mainly concerned with the flowering characteristic of *Adonis vernalis* L. populations. For this purpose we studied the course of flowering of a population planted into our experimental field at Budakalász. In the diagram (Fig. 1) the percentage distribution of plant individuals (within the sample) are illustrated on the basis of their Index-V values. As seen, on 23. March, almost two-third of the plants were in the phenophase of budding and only one-third at the beginning of mass-flowering. On 29. March, mass flowering had already started with 83.3% of the plants in the interval V = −0.50 — −0.10 and reached its maximum probably between 5. and 12. April. As on 12. April 50% of the sample was between V = 0.10 — 0.50, this surmise seems to be right.

To study the characteristics of *Index-G*, on the basis of our investigations in 1976, we have drawn the curve of frequency distribution for Index-G of *Adonis vernalis* L. plant individuals from different native Hungarian populations. As seen in Fig. 1 this is a rightwards slanting distribution. It is characteristic for this empirical distribution that 61.96% of its values are located within the interval G = 0.15—0.50. The majority of plants have a generativity less or equal to 0.50.

Using the Index-G we analysed the generativity of two populations planted in the spring of 1971 and autumn 1974. It could be observed that the population planted in 1971 was more generative. This is elucidated by the fact that among the plants of the population planted in 1974 the percentage of plants less generative than G = 1.0 is 29.7%, while among those of the 1974 planting it is only 16.6%. So, the plant age (also that of the plantation) seems to have an effect on the plant generativity.

In Table 1 the percentage distribution of Index-V and Index-G values are illustrated, as measured in a population in the vicinity of Öskü. It can be seen that 65.2% of the plants have a generativity less than G = 1.0. This is partly verified by our observations on the frequency distribution of the Index-G values (see Fig. 2). The higher values of Index-G go with a
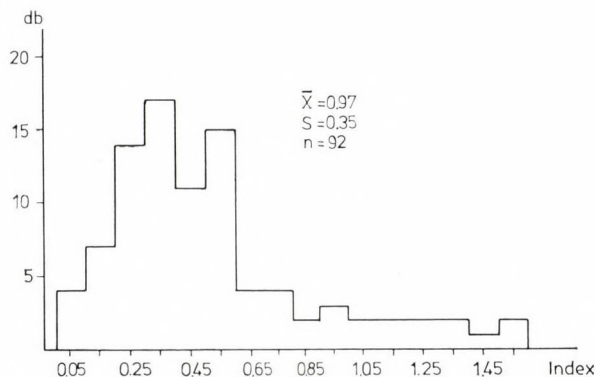
Fig. 1. Frequency distribution of Index-G values in Hungary (1976)

Table 1

Flowering and Generativity spectrum of an Adonis vernalis L. population based on the percentage distribution of plant individuals (Öskü, 14. April 1977)

Phenophases according to the values of Index-V					Degree of generativity (G)	Sum of the phenophases
Budding	Mass flowering			Fruit setting		
	Beginning	Flowering	End			
−1.0 — −0.51	−0.5 — −0.1	0	0.1—0.5	0.51—1.0		
—	—	—	—	—	0.0—0.25	—
4.7	2.3	14.0	7.0	9.3	0.26—0.50	37.3
2.3	10.5	4.7	10.5	—	0.51—1.00	27.9
—	4.7	1.1	4.7	—	1.01—2.00	10.6
2.3	3.5	5.8	3.5	—	2.01—4.00	15.1
1.1	1.1	5.8	—	1.1	4.01	9.1
10.4	22.1	31.4	25.7	10.4		100.0

n = 86

decreasing tendency in the values of frequency percentages. Remarkably, plants more generative than G = 2.0 have a relatively high frequency (24.2%). When analysing the values of Index-V it seems conspicuous that 31.4% of the entire population is in full-flowering. Since 36.1% of the plants are already beyond flowering and only 32.5% has not reached this phenophase, it can be concluded that the population has already over-stepped the phenophase of mass-flowering.

By studying the *Index-V* values as a function of generativity, we gained further data on the flowering dynamics of plants with different generativity. As seen, plants less generative than G = 0.51 are mainly beyond flowering (in full-flowering 14.0%, at the end of flowering 7.0%, in deflorescence 9.3%). As an opposite to this, plants of the generativity between 1.0—2.0 are also in full-flowering, those of the interval 2.0—4.0 have not reached this phenophase, yet. There is a similarity in the case of the most generative plants, too. On the basis of our observations it can be concluded that plants of smaller generativity (G = 0.26—0.50) have left the phenophase of flowering the most quickly.

With the increase of generativity the protraction of flowering can also be observed. Our data, to some extent, contradict those of Poshkurlat (1966), according to whom, the most generative plants begin their growth at the earliest. Referring to our data, it seems possible that at a given time the flowering of these plants lasts longer. Therefore, it is possible that at a given time, the flowering of plants with smaller generativity is more advanced.

Three weeks later, we analysed an other population situated in the vicinity of Budakalász, on the same principles. The frequency distribution curve of Index-G values manifested itself similar to that experienced in the population at Öskü (see Fig. 1). 44.3% of the plant individuals of the population can be found in the interval between G = 0.26—0.50. When considering the process of flowering as a function of generativity (Table 2) it can be established that 68.2% of the population is in the phenophase of fruit-setting and as a whole 83.0% is already beyond full-flowering. The entire population is already in the phenophase of fruit-setting. As a contradiction to this, plants of the highest generativity (G = 2.01—4.0) have not reached full-flowering, yet.
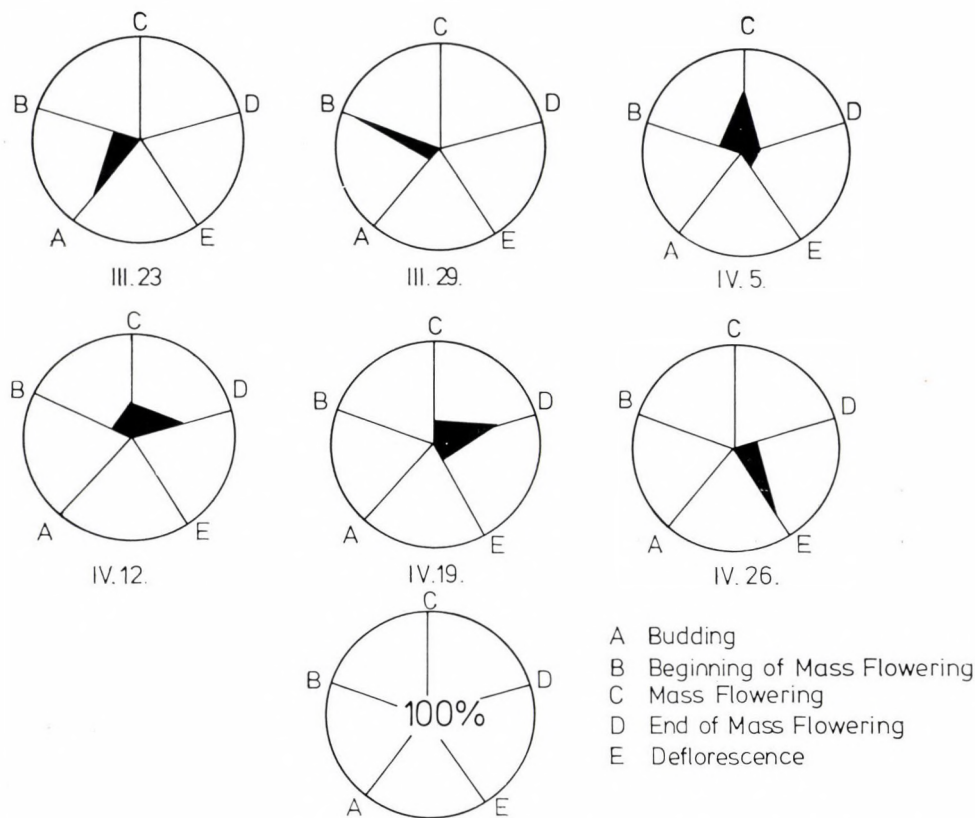
Fig. 2. Changing of phenophases according to the Index-V values (Budakalász, 1976)

Table 2

Flowering and generativity spectrum of an Adonis vernalis L. population based on the percentage distribution of plant individuals (Budakalász, 3. May 1977)

Phenophases according to the values of Index-V					Degree of generativity (G)	Sum of the phenophases
Budding	Mass-flowering			Fruit setting		
	Beginning	Flowering	End			
−1.0 — −0.51	−0.5 — −0.1	0	0.1—0.5	0.51—1.0		
—	—	1.8	2.7	17.7	0.00—0.25	22.2
—	0.9	6.2	5.3	31.9	0.26—0.50	44.3
—	1.8	1.8	3.4	16.8	0.51—1.00	23.8
—	1.8	—	3.4	0.9	1.01—2.00	6.1
1.8	—	0.9	—	0.9	2.01—4.00	-3.6
1.8	4.5	10.7	14.8	68.2		100.0

n = 113

Summarising our observations it can be stated that the *Index-V* and *-G* are suitable for the characterization not only of plant individuals but also populations of *Adonis vernalis* L. The curve of frequency distribution of Index-G values of plant individuals from different native Hungarian populations differs from that of the normal frequency distribution. This rightwards slanting curve can be characterised by 61.96% of its values falling into the interval between G = 0.15—0.50. Within the populations the distribution of plant individuals is similar. The analyses of the flowering phenophase as a function of generativity resulted in the conclusion that within a population the process of flowering of highly generative plants is protracted.

REFERENCES

MÁTHÉ, Á. (1977): Az Adonis vernalis L. virágzásának számszerű kifejezése (Numerical expression of the flowering of Adonis vernalis L.). Herba Hung. **16** (2), 35—47. (Adonis vernalis L.)

Пошкурлат, А. П. (1966): Материалы стационарных наблюдений за развитием горицвета весенного (Adonis verhalis L.) Бюллотень М. О-ва Исп. Природы, Отд. Биологии, **71** (2), 83—99.

Пошкурлат, А. П.—Колесников, Д. Г.—Томенко, Л. А. (1971): Урожайность горицвета весенного и содержание в нем гликозидов. Раст. Ресурсы, **7** (3), 329—341.

Acta Botanica Academiae Scientiarum Hungaricae, Tomus 25 (1—2), pp. 89—106 (1979)

DER ELEMENTGEHALT DER KRAUTIGEN VEGETATION DES QUERCETUM PETRAEAE-CERRIS-WALDES VON SÍKFŐKÚT*

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In den Vegetationsperioden 1974 und 1975 wurde der N, P, K, Ca, Mg, Fe, Mn und Na-Gehalt der krautigen Pflanzen des Síkfőkúter *Quercetum petraeae-cerris* (Nord-Ungarn) untersucht. Anhand der monatlichen Messungen wurde der Elementgehalt der Phytomasse und dessen Verteilung auf Fraktionen berechnet. Im Mittel der zweijährigen Messungen beträgt der maximale Elementgehalt 17,07 kg/ha und dessen größter Teil — mehr als 50% — akkumuliert sich in den unterirdischen Pflanzenteilen. Die Reihenfolge der Elementakkumulierung in den Phytomassefraktionen ist folgende:

oberirdisch lebend — $K > N > P > Ca > Mg > Fe > Mn > Na$

oberirdisch abgestorben: — $N > K > Ca \leqq Fe > P > Mg > Mn > Na$

unterirdisch: — $N > K > Ca > Fe > Mg > P \leqq Mn > Na$

Bei einem Vergleich der Elementverteilung in den Fraktionen wurde festgestellt, daß die Bedeutung der oberirdischen lebenden Phytomasse für die Akkumulierung der verschiedenen Elemente in der Reihenfolge K, P, N, Na, Mg, Ca, Mn, Fe abnimmt, was im Gegensatz zur unterirdischen Phytomasse steht. Die jährliche Elementaufnahme, die tägliche Nährstoffzunahme bzw. der -verlust der Fraktionen, sowie das Austauschverhältnis der Elemente der krautigen Vegetation wurden berechnet.

Einleitung

Eine Aufgabe der Ökosystemforschung der Wälder ist die Untersuchung der Krautschicht als eines Primärproduzenten des Ökosystems. Zahlreiche Verfasser (Neshatajew et al. 1966, Remesowa 1971, Rodin und Basilewich 1967) betonen, daß die Krautschicht im biologischen Kreislauf der Elemente eine besondere Rolle spielt, da es sich hierbei um die dynamischste Einheit der Wälder handelt. Die Rolle der Krautschicht im biologischen Kreislauf der Elemente wurde bereits in zahlreichen blattabwerfenden Waldtypen untersucht (Duvigneaud 1974, Duvigneaud et al. 1971, Ignat'ewa 1971, Kolek und Fulajtár 1970, Ovington 1962, Remesowa 1971, Ulehlová, Klimo und Jakrlová 1975).

Vorliegende Arbeit faßt Ergebnisse von Untersuchungen des Elementgehalts der Krautschicht eines *Quercetum petraeae-cerris*-Waldes einer Hügellandschaft in der Nähe von Síkfőkút zusammen, die parallel zu Phytomassen- und Produktionsuntersuchungen in den Vegetationsperioden 1974 und 1975 durchgeführt wurden. Die Hauptzielsetzungen können folgendermaßen zusammengefaßt werden:

— Verfolgung des Elementgehalts der krautigen Phytomasse (bzw. der Mineralomasse) und der jahreszeitlichen Änderung der Elementmengen
sowie

* Síkfőkút-Project Nr. 41.

— Erschließung der quantitativen Verhältnisse der in der Phytomasse akkumulierten Elemente sowie der Rolle der Phytomassenfraktionen für die Akkumulierung verschiedener Elemente.

Material und Methode

Die Untersuchungen wurden in Síkfőkút (Nord-Ungarn) auf der Ökosystemforschungs-Modellfläche des vom Lehrstuhl für Botanik der Lajos-Kossuth-Universität Debrecen geleiteten »Síkfőkút-Project« (JAKUCS 1973) durchgeführt.

Die Elementgehalte wurden in der Phytomasse der fünf dominanten krautigen Arten des *Quercetum petraeae-cerris* — *Poa nemoralis, Melica uniflora, Dactylis polygama, Carex michelii, Carex montana* — bestimmt. Die Probeentnahme erfolgte in beiden Untersuchungsjahren (1974, 1975) monatlich, wobei als Beginn der Vegetationsperiode der Monat März, als deren Ende dagegen der November betrachtet wurden (Probeentnahmedaten s. Tabelle 1). Bei *Poa nemoralis* und *Melica uniflora* wurde die sog. Monolithmethode, bei *Carex montana, Carex michelii* und *Dactylis polygama* dagegen die sog. Einzelprobeentnahme angewandt. Dabei auftretende Probleme und bei krautigen Pflanzen verwendete Probeentnahmemethoden werden von JAKUCS und PAPP (1974) ausführlich dargestellt. Das mit Hilfe beider Methoden gesammelte Pflanzenmaterial wurde in oberirdische lebende, oberirdische noch stehende aber bereits abgestorbene und unterirdische Fraktionen getrennt. Die Trennung von abgestorbener und mit der Mutterpflanze nicht mehr in Verbindung stehender krautiger Streufraktion war im Wald nicht zu lösen. Eine Ursache dafür ist, daß 80—90% der oberirdischen abgestorbenen Teile des hauptsächlich aus Gräsern bestehenden Unterwuchses abgebaut werden (nach ihrem Absterben) indem sie noch in Verbindung mit der Pflanze bleiben. (So gelangen diese in die oberirdische noch stehende aber bereits abgestorbene Fraktion.) Die trotzdem auf den Boden fallenden abgestorbenen Streuteile vermischen sich derartig mit bodenbedeckendem, dürrem Laub von Bäumen und Sträuchern, daß ihre Trennung methodisch nicht zu lösen ist.

Zur chemischen Analyse wurden die Pflanzenproben pulverisiert und bei 85 °C getrocknet. Die Bestimmung des Gesamt-N und Gesamt-P-Gehalts erfolgte nach nassem Aufschluß. Das entstandene Ammoniak wurde nach Destillation in 2%iger Borsäure aufgefangen und mit 0,01 n HCl titriert.

Der P-Gehalt wurde kolorimetrisch nach der Molybdänblau-Methode mit Askorbinsäure als Reduktionsmittel bestimmt. Nach Glühen bei 500 °C und anschließendem Aufschluß mit HCl : HNO_3 : H_2O im Verhältnis 1 : 1 : 8 erfolgte die Bestimmung der Elemente K, Ca, Mg, Fe, Mn und Na mit einem Atomabsorptionsspektrophotometer des Typs UNICAM SP 1900.

Ergebnisse

Die zur chemischen Analyse, die parallel zu Phytomassenmessungen durchgeführt wurde, ausgesuchten krautigen Pflanzen sind anhand der Strukturaufnahmen (PAPP 1978) die frequentesten Arten der Krautschicht des *Quercetum petraeae-cerris*, und die Summe ihrer Phytomassen (Tab. 1) ist während der Vegetationsperiode nur um wenige Prozente niedriger als die gesamte krautige Phytomasse. Deshalb ist es möglich, den Elementgehalt der Phytomasse der fünf krautigen Arten zur Charakterisierung der Krautschicht des Waldes heranzuziehen. Die jahreszeitliche Veränderung der Elementkonzentrationen in den verschiedenen Fraktionen der Arten wurde bereits in einer früheren Veröffentlichung (MÉSZÁROS 1977) vorgestellt; die Berechnung der in der Phytomasse akkumulierten Elementmengen erfolgte in Kenntnis der dort mitgeteilten Ergebnisse sowie der Phytomasse (Tab. 2 und 3).

Die jahreszeitliche Veränderung der Phytomasse und ihres Gesamtelementgehaltes

Die Phytomasse und deren Elementgehalt bzw. die Mineralomasse zeigen sehr ähnliche Veränderungen in den Vegetationsperioden.

Tabelle 1

Summe der Phytomassen (g/ha) von Poa nemoralis, Melica uniflora, Dactylis polygama, Carex michelii und Carex montana (berechnet anhand der Messungen von M. Papp)

Zeitpunkt der Probeentnahme 1974	Oberirdisch		Unterirdisch	Gesamt
	lebend	abgestorben		
13. III.	25 381,75	76 899,57	170 738,57	273 019,89
3. IV.	57 904,83	57 178,81	199 038,06	314 121,70
24. IV.	69 089,52	66 860,57	262 874,35	398 824,44
22. V.	96 649,30	66 291,09	218 130,06	381 070,45
26. VI.	138 485,42	56 819,93	261 354,34	456 659,69
31. VII.	143 674,80	47 516,52	238 542,84	429 734,16
6. IX.	166 664,42	85 816,93	239 635,60	492 116,95
2. X.	121 848,73	97 388,89	263 053,28	482 290,90

Zeitpunkt der Probeentnahme 1975	Oberirdisch		Unterirdisch	Gesamt
	lebend	abgestorben		
13. III.	36 332,95	66 003,65	224 576,79	326 913,39
9. IV.	95 959,22	59 900,37	292 548,51	448 408,10
30. IV.	166 132,34	46 780,73	258 581,09	471 494,16
26. V.	173 703,10	70 720,85	306 348,71	550 772,66
18. VI.	218 694,75	67 416,36	295 441,37	581 552,48
11. VII.	179 738,38	43 658,33	320 853,83	544 250,54
12. VIII.	167 135,71	55 777,89	314 945,75	537 859,35
17. IX.	167 728,32	70 430,65	238 337,33	476 496,30
22. X.	151 072,94	96 132,15	227 857,07	475 062,16

Im Frühjahr zu Wachstumsbeginn stellt die Mineralomasse, die 1974 8069 g/ha, 1975 dagegen 11 052 g/ha betrug, ebenso wie die Phytomasse (1974 273019 g/ha, 1975 326 913 g/ha) lediglich 50—60% des Maximalwertes dar, später erhöhen sich beide und erreichen im Sommer den höchsten Wert; bis zum Herbst ist eine Abnahme festzustellen. Der maximale Elementgehalt der Phytomasse wurde in beiden Jahren im Juni gemessen (1974 13 013 g/ha und 1975 21 121 g/ha). Im Jahre 1974 fielen die Zeitpunkte der Maxima von Phyto- und Mineralomasse nicht zusammen; das Phytomassenmaximum wurde zwei Monate später, im September gemessen. Im Mittel der Messungen beider Jahre betrug der maximale Elementgehalt der Phytomasse 17,07 kg/ha, der Elementgehalt des Phytomassenmaximums dagegen 16,76 kg/ha.

Wie aus den Tabellen (Tab. 1, 2, 3) hervorgeht, bestehen zwischen den Fraktionen bedeutende Unterschiede. Die größte Abweichung in Phyto- und Mineralomasse ist für die oberirdische lebende Fraktion charakteristisch; die Phytomasse dieser Fraktion macht im zeitigen Frühjahr lediglich 15—16%, ihre Mineralomasse dagegen 20—30% des maximalen Wertes uas, demgegenüber weisen die unterirdischen Pflanzenteile, deren Phytomasse nur 30—35% beträgt, in der Vegetationszeit im Elementgehalt eine 35—40%ige Fluktuation auf. Es muß allerdings bemerkt werden, daß das Verhältnis der Veränderungen nicht gleich ist, obwohl die Tendenzen der Phytomassen- und Elementgehaltveränderungen einander sehr ähnlich sind.

Am auffälligsten ist diese Erscheinung bei der oberirdischen lebenden Fraktion in der intensiven Wachstumsphase, wenn die Phytomassenzunahme 56—62%, die der Mineralomasse dagegen nur 48—51% ausmacht. Das ist damit zu erklären, daß in diesem Zeitraum der Gesamtelementgehalt in den oberirdischen lebenden Pflanzenteilen — hauptsächlich wegen eines starken Abfalls der N- und K-Konzentration (MÉSZÁROS 1977) — abnimmt, was zwar keine Senkung der Mineralomasse verursacht, wohl aber die Intensität der Zunahme verringert.

Verteilung von Phytomasse und ihrem Elementgehalt auf Fraktionen

Die durchgeführten Phytomassen- und Elementgehaltsbestimmungen boten eine Möglicheit dafür, Antwort auf die Frage zu erhalten, ob ein Unterschied in der Verteilung der Phytomasse und deren Elementgehalt in Fraktionen besteht. Die mittlere jährliche Verteilung der Fraktionen wurde in Tabelle 4 zusammengefaßt. Die für zwei Jahre berechnete mittlere prozentuale Verteilung zeigt keine große Abweichung, es kann aber festgestellt werden, daß der Anteil der oberirdischen lebenden Pflanzenteile sowohl an Phytomasse als auch an Elementgehalt im Jahre 1975 höher war als 1974. Das ist mit der während der Vegetationsperiode gefallenen unterschiedlichen Niederschlagsmenge zu erklären, die 1974 471 mm, 1975 dagegen 600 mm betrug (NAGY 1978).

Auf die oberirdischen lebenden Pflanzenteile entfällt in beiden Jahren ein höherer Mineralomassen- als Phytomassenanteil, was im Gegensatz zu den beiden anderen Fraktionen steht. Im vom Durchschnitt abweichenden Prozentsatz ist dies doch für jeden Probeentnahmezeitpunkt während der Vegetationsperioden gültig, d.h. die oberirdischen lebenden Teile haben eine größere Bedeutung für die Elementakkumulation, als das anhand der Phytomassenverteilung zu erwarten wäre.

Die Bedeutung der Phytomassenfraktionen für die Akkumulierung der untersuchten Elemente

Die mittlere prozentuale Verteilung der Gesamtelementmenge auf Fraktionen unterscheidet sich in hohem Maße von der mittleren Verteilung der Mineralomasse (Abb. 1), lediglich die Verteilung von N und P nähert sich dieser am besten. Wegen der größeren Masse der unterirdischen Teile haben diese für die Elementakkumulation eine größere Bedeutung als die anderen beiden Fraktionen.

Die Bedeutung der oberirdischen lebenden Phytomasse für die Akkumulation verschiedener Elemente nimmt in folgender Reihenfolge ab: K, P, N, Na, Mg, Ca, Mn, Fe. Die der unterirdischen Phytomasse ist dieser gerade entgegengesetzt. Die oberirdische lebende Phytomasse spielt eine hervorragende Rolle für die K-Akkumulierung, die sogar die N- und P-Akkumulation um ungefähr das Zweifache übersteigt. Bei der unterirdischen Phytomasse muß die hohe Fe, Mn und Ca-Akkumulierung erwähnt werden, die wahrscheinlich das Ergebnis schwacher Mobilisierbarkeit ist. Über eine höhere Akkumulation von K, N und P durch die oberirdische lebende Phytomasse berichteten auch die Krautschicht anderer Waldgesellschaften untersuchende Forscher (DUVIGNEAUD 1974, DUVIGNEAUD et al. 1971, IGNAT'EWA 1971, REMESOWA 1971, RODIN und BASILEWICH 1967).

Die mittlere jährliche Verteilung widerspiegelt die Unterschiede in der Elementverteilung, die zu jedem beliebigen Zeitpunkt der Vegetationsperiode bestehen, wenn auch die Werte abweichen. Die unterirdischen Teile spielen noch im Frühjahr eine große Rolle in der K-Akkumulation, zu diesem Zeitpunkt befinden sich in beiden Jahren mehr als 40% des K-Gehalts in den unterirdischen Teilen oder z.B. 90% des Fe und mehr als 80% Mn. Die größte Elementakkumulation der oberirdischen lebenden Phytomasse ist im Sommer (Mai, Juni, Juli) zu
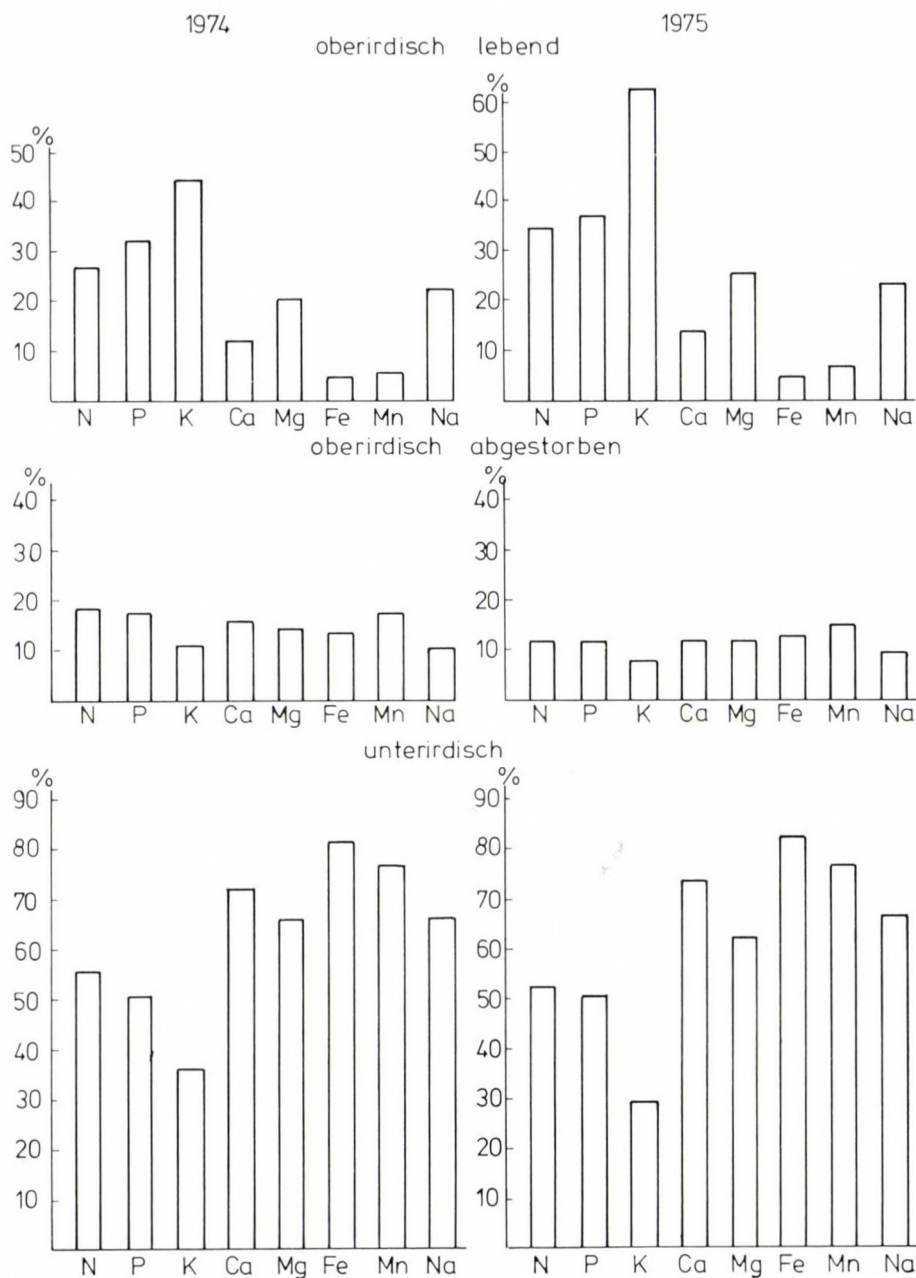
Abb. 1. **Mittlere jährliche Verteilung (%) der Elemente in den Fraktionen**

Tabelle 2

Elementmengen (g/ha) in der Krautschicht nach Fraktionen und als Summe — 1974

		N	P	K	Ca	Mg	Fe	Mn	Na	Gesamt
13. März	a	736,67	92,05	574,63	33,87	31,48	12,43	7,26	5,99	1 494,38
	b	957,94	99,39	265,19	127,77	58,15	95,53	74,71	7,05	1 685,73
	c	2 389,70	197,44	753,72	417,02	255,20	616,76	224,83	34,63	4 889,30
		4 084,31	388,88	1 593,54	578,66	344,83	724,72	306,80	47,67	8 069,41
3. April	a	1 396,32	146,53	1 189,53	69,09	80,50	14,65	9,00	9,59	2 915,21
	b	1 286,13	82,98	300,75	116,70	50,70	37,64	36,31	6,28	1 917,49
	c	3 329,07	223,90	980,88	473,94	284,79	555,16	238,37	46,28	6 132,39
		6 011,52	453,41	2 471,16	659,81	415,99	607,45	283,68	62,15	10 965,09
24. April	a	1 514,32	-143,06	1 392,49	79,61	89,74	13,18	10,73	10,27	3 253,40
	b	1 021,55	95,02	388,87	129,61	66,58	38,51	56,97	5,29	1 802,40
	c	3 975,87	356,71	1 080,60	691,55	387,43	836,62	488,57	55,02	7 872,37
		6 511,74	594,79	2 861,96	900,77	543,75	888,31	556,27	70,58	12 928,17
22. Mai	a	1 528,23	212,06	1 796,70	104,16	154,81	115,27	38,39	27,58	3 977,20
	b	866,31	89,84	212,39	100,34	84,66	242,71	102,02	15,23	1 713,50
	c	2 753,30	277,25	908,91	635,19	323,10	513,51	280,45	49,26	5 740,97
		5 147,84	579,15	2 918,00	839,69	562,57	871,49	420,86	92,07	11 431,67
26. Juni	a	1 778,44	258,97	2 423,32	187,29	123,84	36,98	27,85	27,26	4 863,95
	b	664,57	81,71	300,40	152,86	54,68	71,96	50,86	6,20	1 383,24
	c	3 002,47	340,47	1 177,63	739,46	341,22	785,10	321,33	58,69	6 766,38
		5 445,48	681,15	3 901,35	1 079,61	519,75	894,04	400,04	92,15	13 013,57
31. Juli	a	1 461,03	249,67	2 586,47	152,53	114,37	38,09	23,85	17,07	4 643,08
	b	600,32	71,42	243,19	120,69	58,42	38,58	31,49	4,30	1 168,41
	c	2 884,26	351,32	1 038,25	809,16	304,16	522,24	219,33	38,95	6 167,67
		4 945,61	672,41	3 867,91	1 082,38	476,95	598,91	274,67	60,32	11 979,16

6. September	a	1 720,26	244,73	1 863,17	189,85	139,28	47,47	25,30	14,41	4 244,47
	b	1 047,03	109,86	294,72	221,58	96,27	145,06	69,20	5,63	1 989,35
	c	2 850,68	299,59	935,67	867,34	328,03	596,58	241,71	43,28	6 162,88
		5 617,97	654,18	3 093,56	1 278,77	563,58	789,11	336,21	63,32	12 396,70
2. Oktober	a	1 068,98	150,61	1 423,25	176,30	84,78	35,75	21,36	25,21	2 986,24
	b	1 102,08	132,45	320,01	238,12	79,30	192,45	83,48	12,08	2 159,97
	c	2 396,18	267,69	981,83	931,06	359,68	645,63	302,50	50,66	5 935,23
		4 567,24	550,75	2 725,09	1 345,48	523,76	873,96	407,34	87,95	11 081,44

a: oberirdische lebende Phytomassenfraktion
b: oberirdische abgestorbene Phytomassenfraktion
c: unterirdische Phytomassenfraktion

Tabelle 3

Elementmengen (g/ha) in der Krautschicht nach Fraktionen und als Summe — 1975

		N	P	K	Ca	Mg	Fe	Mn	Na	Gesamt
13. März	a	1 102,28	101,42	734,61	87,03	50,06	16,06	8,58	7,07	2 107,11
	b	917,38	79,70	291,58	160,53	51,13	74,88	47,65	6,30	1 629,15
	c	3 325,60	314,39	1 091,50	1 270,73	344,48	739,65	184,17	45,29	7 315,81
		5 345,26	495,51	2 117,69	1 518,29	445,67	830,59	240,40	58,66	11 052,07
9. April	a	2 180,78	255,39	1 483,44	180,01	140,62	37,70	19,27	9,20	4 306,41
	b	669,79	65,89	216,31	168,60	56,05	84,45	54,68	6,23	1 322,00
	c	4 223,85	313,53	1 225,02	1 543,86	411,35	698,33	368,65	67,10	8 851,69
		7 074,42	634,81	2 924,77	1 892,47	608,02	820,48	442,60	82,53	14 480,10
30. April	a	3 258,65	265,57	5 461,16	214,08	195,79	41,08	14,46	21,97	9 472,76
	b	700,98	49,33	288,38	120,13	54,12	86,84	42,55	6,26	1 348,59
	c	3 384,54	236,76	1 408,06	902,47	415,58	1 150,70	364,61	62,95	7 925,67
		7 344,17	551,66	7 157,60	1 236,68	665,49	1 278,62	421,62	91,18	18 747,02
26. Mai	a	2 598,78	295,87	4 096,73	237,67	191,70	96,61	32,46	22,12	7 571,88
	b	823,17	60,38	387,04	123,77	95,04	256,47	86,97	9,01	1 841,85
	c	3 472,06	332,87	1 583,29	910,44	413,72	1 120,62	458,60	60,59	8 352,19
		6 894,01	689,06	6 067,06	1 271,88	700,46	1 473,70	578,03	91,72	17 765,92
18. Juni	a	3 760,28	381,09	5 902,21	399,96	219,53	94,48	37,04	55,50	10 850,09
	b	1 010,63	71,13	232,25	145,27	63,67	171,41	62,66	19,76	1 776,78
	c	4 205,04	378,91	1 523,90	1 105,56	361,12	553,64	276,51	89,91	8 494,59
		8 975,95	831,13	7 657,36	1 650,79	644,32	819,53	376,21	165,17	21 121,46
11. Juli	a	2 559,69	264,92	5 103,24	246,87	218,58	47,58	39,16	28,72	8 508,76
	b	621,50	66,07	362,47	148,69	59,38	60,29	35,42	5,19	1 359,01
	c	3 782,30	349,63	1 599,06	1 231,09	400,42	1 058,17	383,15	65,26	8 869,08
		6 963,49	680,62	7 064,77	1 626,65	678,38	1 166,04	457,73	99,17	18 736,85

12. August	a	2 047,64	232,41	3 179,28	178,88	158,00	32,06	35,10	18,97	5 882,34
	b	724,76	97,03	368,39	164,99	73,45	57,91	51,69	5,10	1 543,32
	c	3 576,98	393,80	1 500,94	1 059,65	425,60	810,58	375,69	55,14	8 198,38
		6 349,38	723,24	5 048,61	1 403,52	657,05	900,55	462,48	79,21	15 624,04
17. September	a	2 750,48	226,78	3 007,59	169,41	148,82	35,18	41,97	18,58	6 398,81
	b	873,70	79,93	353,65	189,57	77,91	60,56	59,18	6,02	1 700,52
	c	3 048,50	314,13	1 144,09	751,69	320,70	680,89	257,79	35,61	6 553,40
		6 672,68	620,84	4 505,33	1 110,67	547,43	776,63	358,94	60,21	14 652,73
22. Oktober	a	2 032,81	168,99	1 937,39	151,50	123,86	35,45	38,24	13,22	4 501,46
	b	1 434,23	96,34	552,72	247,16	115,83	177,88	107,04	8,70	2 739,90
	c	3 846,23	287,17	995,30	855,07	303,97	414,12	206,48	37,66	6 946,00
		7 313,27	552,50	3 485,41	1 253,73	543,66	627,45	351,76	59,58	14 187,36

a: oberirdische lebende Phytomassenfraktion
b: oberirdische abgestorbene Phytomassenfraktion
c: unterirdische Phytomassenfraktion

Tabelle 4

Mittlere jährliche Verteilung (%) von Phyto- und Mineralomasse in den Fraktionen

Fraktion	1974		1975	
	Phytomasse	Mineralo-masse	Phytomasse	Mineralo-masse
Oberirdisch lebend	24,11	30.31	29,77	39,08
Oberirdisch abgestorben	17,78	15,40	14,49	10,89
Unterirdisch	58,11	54,29	55,74	50,03

beobachten, in diesen Monaten sind 60—70% des gesamten K, 30—40% des gesamten N, 40—45% des gesamten P, 17—20% des gesamten Ca, 30% des gesamten Mg, 13% des gesamten Fe, 10% des gesamten Mn und 30—40% des gesamten Na in der oberirdischen lebenden Phytomasse anzutreffen.

Während der Vegetationsperiode ist die N, P und Ca-Akkumulation der unterirdischen Teile am gleichmäßigsten, während die oberirdische lebende Phytomasse in der Akkumulation von Mn, Fe und Ca geringe Fluktuation zeigt. Der prozentuale Anteil der oberirdischen abgestorbenen Phytomasse an der Gesamtelementmenge steigt am Ende der Vegetationsperiode, dann erhöht sich im Falle von Ca, Mn und Fe, also schwer translozierender Elemente die Bedeutung dieser Fraktion in einem Solchen Maße, daß sogar die der oberirdischen lebenden Pflanzenteile übertroffen wird. So sind 18—19% des Gesamt-Ca-Gehalts, 22—28% des Gesamt-Fe-Gehalts und 20—30% des Gesamt-Mn-Gehalts in den abgestorbenen oberirdischen Teilen anzutreffen, während der auf die oberirdischen lebenden Teile entfallende Anteil bei Ca 12—15%, bei Fe 4—6% und bei Mn 5—10% ausmacht.

Im Gegensatz zu den drei oben genannten Elementen ist bei den übrigen Elementen aussehließlich starke Zunahme zu beobachten, die allerdings den prozentualen Anteil der oberirdischen lebenden Teile nicht erreicht, was mit der durch Physiologen beschriebenen Translokationserscheinung in Zusammenhang gebracht werden kann (Epstein 1972, Mengel 1968, Ramani und Kannan 1975).

Nicht nur die Fraktionsvertnilung der untersuchten Elemente ist unterschiedlich, sondern diese werden von den Phytomassenfraktionen in abweichender Reihenfolge und Menge akkumuliert. In den drei Phytomassenfraktionen gestaltet sich die Akkumulationsreihenfolge der Elemente folgendermaßen:

oberidisch lebend: $K > N > P > Ca > Mg > Fe > Mn > Na$

oberirdisch abgestorben: $N > K > Ca \leqq Fe > P > Mg > Mn > Na$

unterirdisch: $N > K > Ca > Fe > Mg > P \leqq Mn > Na$

Die krautige Phytomasse enthält N und K in der größten Menge (Tabellen 2 und 3), der Gehalt an den übrigen Makroelementen ist im allgemeinen um eine Größenordnung kleiner. Am wenigsten enthält die krautige Phytomasse Na; sein Anteil ist im Vergleich zu Stickstoff um 70—80 mal, mit K verglichen 40—50 mal niedriger. Der Na-Gehalt ist selbst im Vergleich zur Mikroelementmenge noch niedrig; im Mittel ein Zehntel des Fe-Gehalts und ein Fünftel bis Sechstel des Mn-Gehalts. Die prozentuale Zusammensetzung der Mineralomasse, die zum Zeitpunkt der krautigen Phytomassenmaxima bestimmt wurde, geht nach Fraktionen und
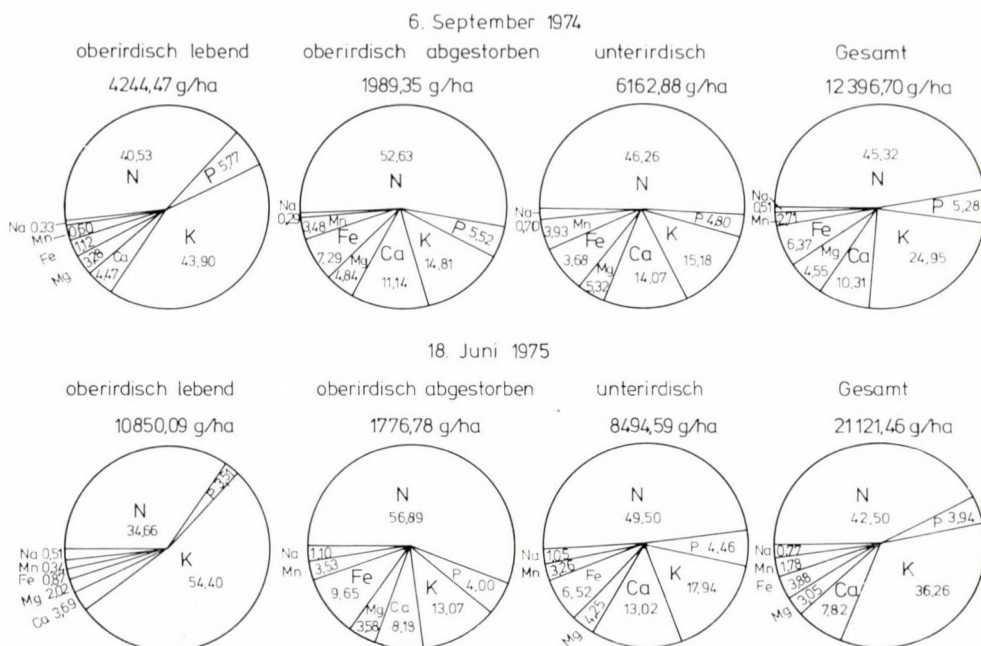
Abb. 2. **Elementzusammensetzung der Mineralomasse (%) zum Zeitpunkt der Phytomassen-maxima**

als Summe aus Abbildung 2 hervor. Mehr als 80% des Gesamtelementgehalts der oberirdischen lebenden Phytomasse machen K und N aus, der Fe- und Mn-Gehalt ergibt dagegen nur 2%. Gegenüber der lebenden sinkt die Dominanz der N- und K-Mengen in der abgestorbenen und unterirdischen Phytomasse unter 70%, der Anteil von Fe und Mn erhöht sich auf fast das Zehnfache, der von Ca dagegen auf das Dreifache. (Die bedeutende Abnahme von K und N in der unterirdischen Phytomasse kann auch mit methodischen Problemen zusammenhängen; die Auswaschung der Wurzeln mit Wasser kann nämlich in erster Linie diese Elemente beeinflussen.)

Die jährliche Produktion und Elementaufnahme der krautigen Pflanzen

Die jahreszeitliche Untersuchung von Phytomasse und Elementgehalt ermöglichte eine Schätzung der Primärproduktion und Elementaufhahme der gesamten Krautschicht. Die NPP der Krautschicht im *Quercetum petraeae-cerris* wird von Papp (1978) ausführlich angegeben, an dieser Stelle soll lediglich bemerkt werden, daß zur Schätzung der NPP-Werte die addierte Phytomasse der fünf Arten in der Weise verwendet wurde, daß bei der Berechnung der oberirdischen Produktion dem Zuwachs an lebender oberirdischer Phytomasse während der Vegetationsperiode auch das bis dahin gemessene Wachstum der oberirdischen stehenden abgestorbenen Fraktion zugerechnet wurde. Zur Schätzung der unterirdischen Produktion wurden die maximalen und minimalen unterirduschen Phytomassenunterschiede verwendet. Es wurde versucht, die jährlich aufgenommenen Elementmengen mit einer der Produktionsberechn ung ähnlichen Methode zu erfassen. Tabelle 5 enthält die ober- und unterirdischen Produktionswerte sowie die jährlich aufgenommenen Elementmengen.

Tabelle 5

Jahresproduktion und Elementaufnahme in der Krautschicht

	Produktion	N	P	K
				g/ha/
				1974
Oberirdisch	189 264,84	1369,96	178,96	2223,53
Unterirdisch	92 314,71	1586,17	159,27	423,91
Gesamt	281 579,55	2956,13	338,23	2647,44
				1975
Oberirdisch	206 301,91	2998,84	301,47	5338,33
Unterirdisch	96 277,04	1175,35	157,04	603,76
Gesamt	302 578,95	4174,19	458,51	5942,09

Die jährliche Nährstoffzunahme der oberirdischen Phytomasse betrug in beiden Jahren 75% des maximalen Elementgehalts; im Gegensatz dazu betrug die Nährstoffzunahme der unterirdischen Phytomasse lediglich 44% des Maximums. Das zeigt, daß der Stoffwechsel der oberirdischen Phytomasse wesentlich intensiver ist als der der unterirdischen, was auch verständlich ist, geht doch eine bedeutende Wurzelphytomasse aus einer Vegetationsperiode in die andere über. Der Hauptanteil der jährlich aufgenommenen Elementmenge wird von K und N dargestellt. Die jährliche Zunahme der oberirdischen und unterirdischen Phytomasse unterscheidet sich besonders bei einem Element, bei K beträchtlich. Die jährliche K-Zunahme der oberirdischen Phytomasse übersteigt die unterirdische bedeutend, 1974 um das Fünf- und 1975 um das Neunfache. Der jährliche Zuwachs an Ca, Fe und Mn (1974 auch der von N) ist dagegen in der unterirdischen Phytomasse größer.

Tägliche Nährstoffzunahme bzw. -verlust der krautigen Phytomasse

Die Phytomasse sowie im Falle der Elemente die tägliche Gewichtszunahme oder -abnahme zwischen den Probeentnahmen wurden in den Tab. 6 und 7 zusammengefaßt. Die Werte drücken eine gewisse »Produktionsgeschwindigkeit« aus. Die Produktionswerte der Phytomasse waren in beiden Untersuchungsperioden im Juni am höchsten und parallel dazu verlief die Nährstoffixierung in der krautigen Phytomasse. Diese bis zum Sommer anhaltende intensive Elementaufnahme wurde aber in beiden Jahren im Mai von Nährstoffverlust gestört, der 1974 —53,43 g/ha/Tag und 1975 —37,72 g/ha/Tag betrug. 1974 ist dieser Verlust ein Ergebnis der Abnahme des Nährstoffgehalts der unterirdischen Phytomasse, 1975 dagegen der oberirdischen lebenden Phytomasse. 1974 war ein negativer Produktionswert der Phytomasse auch mit Nährstoffverlust gepaart.

(berechnet nach Daten der fünf untersuchten Arten)

Ca	Mg	Fe	Mn	Na	Gesamt
Jahr					
322,30	157,29	307,04	96,84	31,53	4 687,45
514,04	132,23	323,11	269,24	24,06	3 432,03
836,34	289,52	630,15	366,08	55,59	8 119,48
346,14	215,31	262,14	108,69	61,96	9 632,79
792,17	121,63	736,58	274,43	54,30	3 915,26
1138,31	336,94	998,72	383,03	116,26	13 548,05

Die sich auf das Jahr 1975 beziehenden Werte sind höher und widerspiegeln auch im absoluten Wert stärkere Veränderungen als 1974. Die höchste positive Phytomassenproduktion (4499,80 g/ha/Tag) wurde im März 1975, die höchste Nährstoffixierung (203,20 g/ha/Tag) dagegen im gleichen Jahr, im April festgestellt. Es kann festgestellt werden, daß eine Nährstoffixierung von 100 g/ha/Tag nur im Frühjahr und zu Sommeranfang abläuft. Eine Gewichtsabnahme anzeigende negative Produktionswerte bzw. ein Elementverlust der Phytomasse zeigen sich bereits ab Sommerende.

Tägliche Nährstoffzunahme bzw. -verlust der Phytomassenfraktionen

Für beide Jahre zeigen der Produktionswert der Fraktionen sowie die das Maß der im Nährstoffhaushalt einsetzenden Veränderungen andeutenden Werte eine tiefgreifende Änderung der oberirdischen lebenden und unterirdischen Teile, im Gegensatz zu den oberirdischen noch stehenden abgestorbenen Pflanzenteilen.

In der oberirdischen lebenden Phytomasse spielt sich die Nährstoffixierung bis Juni ab, was einen Zusammenhang mit den positiven Produktionswerten zeigt. Die maximale Nährstoffzunahme dieser Fraktion war im April 1975 zu beobachten (246,02 g/ha/Tag), was die Nährstoffixierung des gleichen Abschnitts der Vegetationsperiode 1974 15mal übertraft. Der zu Sommerende einsetzende Elementverlust der Fraktion war ähnlich zur Fixierung auch 1975 stärker als 1974. Im Jahre 1975 bewegte sich der Nährstoffverlust in dieser Fraktion zwischen —54,21 und —101,79 g/ha/Tag, 1974 dagegen nur zwischen —6,32 und —48,39 g/ha/Tag.

In der oberirdischen lebenden Phytomasse ist die Fixierung von K und N am höchsten und lag 1975 über 50 g/ha/Tag, wogegen das Maximum 1974 kaum 30 g/ha/Tag überschritt.

Tabelle 6

Produktionswerte der Phytomassenfraktionen, tägliche Nährstoffaufnahme bzw. -verlust — 1974

		Produktivität	N	P	K	Ca	Mg	Fe	Mn	Na	Gesamt
			g/ha/Tag								
13. März—3. April	a	+1548,72	+31,41	+2,59	+29,28	+ 1,68	+2,34	+ 0,11	+ 0,08	+0,17	+ 67,66
	b	— 939,08	+15,63	—0,78	+ 1,69	— 0,53	—0,35	— 2,76	— 1,83	—0,04	+ 11,03
	c	+1347,59	+44,73	+1,26	+10,82	+ 2,71	+1,41	— 2,93	+ 0,64	+0,56	+ 59,20
		+1957,23	+91,77	+3,07	+41,79	+ 3,86	+3,40	— 5,58	— 1,11	+0,69	+137,89
3. April—24. April	a	+ 532,60	+ 5,62	—0,17	+ 9,67	+ 0,50	+0,44	— 0,07	+ 0,08	+0,03	+ 16,10
	b	+ 461,04	—12,60	+0,57	+ 4,20	+ 0,61	+0,76	+ 0,04	+ 0,98	—0,05	— 5,49
	c	+3039,82	+30,80	+6,32	+ 4,75	+10,36	+4,89	+13,40	+11,91	+0,42	+ 82,85
		+4033,46	+23,82	+6,72	+18,62	+11,47	+6,09	+13,37	+12,97	+0,40	+ 93,46
24. April—22. Mai	a	+ 984,28	+ 0,50	+2,46	+14,44	+ 0,88	+2,32	+ 3,65	+ 0,99	+0,62	+ 25,86
	b	— 20,34	— 5,54	—0,19	— 6,30	— 1,05	+0,65	+ 7,29	+ 1,61	+0,36	— 3,17
	c	—1598,01	—43,66	—2,84	— 6,13	— 2,01	—2,30	—11,54	— 7,43	—0,21	— 76,12
		— 634,07	—48,68	—0,47	+ 2,54	— 2,15	+0,87	— 0,47	— 5,61	+0,79	— 53,43
22. Mai—26. Juni	a	+1195,32	— 7,15	+1,34	+17,90	+ 2,38	—0,89	— 2,24	— 0,30	—0,01	+ 25,33
	b	— 270,61	— 5,76	—0,23	+ 2,52	+ 1,50	—0,86	— 4,88	— 1,46	—0,26	— 9,43
	c	+1234,98	+ 7,12	+1,81	+ 7,68	+ 2,98	+0,52	+ 7,76	+ 1,17	+0,27	+ 29,31
		+2159,69	+ 8,51	+2,92	+28,10	+ 6,86	—1,23	+ 0,64	— 0,59	0,00	+ 45,21
26. Juni—31. Juli	a	+ 148,27	— 9,07	—0,27	+ 4,66	— 0,99	—0,27	+ 0,03	— 0,12	—0,29	— 6,32
	b	— 265,81	— 1,84	—0,29	— 1,64	— 0,92	+0,11	— 0,95	— 0,55	—0,05	— 6,13
	c	— 651,76	— 3,38	+0,31	— 3,98	+ 1,99	—1,06	— 7,51	— 2,91	—0,56	— 17,10
		— 769,30	—14,29	—0,25	— 0,96	+ 0,08	—1,22	— 8,43	— 3,58	—0,90	— 29,55
31. Juli—6. September	a	+ 621,34	+ 7,01	—0,13	—19,55	+ 1,01	+0,67	+ 0,25	+ 0,04	—0,07	— 10,77
	b	+1035,15	+12,07	+1,04	+ 1,39	+ 2,73	+1,02	+ 2,88	+ 1,02	+0,04	+ 22,19
	c	+ 29,53	— 0,91	—1,40	— 2,77	+ 1,57	+0,65	+ 2,01	+ 0,61	+0,12	— 0,12
		+1686,02	+18,17	—0,49	—20,93	+ 5,31	+2,34	+ 5,14	+ 1,67	+0,09	+ 11,30
6. September—2. Oktober	a	—1723,68	—25,05	—3,62	—16,92	— 0,52	—2,10	— 0,45	— 0,15	+0,42	— 48,39
	b	+ 445,08	+ 2,12	+0,87	+ 0,97	+ 0,64	—0,65	+ 1,82	+ 0,55	+0,25	+ 6,57
	c	+ 900,68	—17,48	—1,23	+ 1,78	+ 2,45	+1,22	+ 1,89	+ 2,34	+0,28	— 8,75
		— 377,92	—40,41	—3,98	—14,17	+ 2,57	—1,53	+ 3,26	+ 2,74	+0,95	— 50,57

a: oberirdische lebende Fraktion b: oberirdische stehende, abgestorbene Fraktion c: unterirdische Fraktion

Tabelle 7

Produktionswerte der Phytomassenfraktionen, tägliche Nährstoffaufnahme bzw. -verlust — 1975

		Produktivität	N	P	K	Ca	Mg	Fe	Mn	Na	Gesamt
			g/ha/Tag								
13. März—9. April	a	+2208,38	+39,94	+5,70	+ 27,73	+ 3,44	+3,35	+ 0,80	+0,39	+0,08	+ 81,43
	b	— 226,05	— 9,17	—0,51	— 2,79	+ 0,30	+0,18	+ 0,35	+0,26	+0,10	— 11,37
	c	+2517,47	+33,27	—0,03	+ 4,95	+10,12	+2 48	— 1,53	+6,38	+0,81	+ 56,90
		+4499,80	+64,04	+5,16	+ 29,89	+13,86	+6,01	— 0,38	+7,48	+0,90	+126,96
9. April—30. April	a	+3341,58	+51,33	+0,49	+189,42	+ 1,62	+2,63	+ 0,16	—0,24	+0,61	+246,02
	b	— 624,74	+ 1,49	—0,79	+ 3,43	— 2,31	—0,09	+ 0,11	—0,58	+0,01	+ 1,27
	c	—1617,50	—39,97	—3,66	+ 8,72	—30,54	+0,20	+21,54	—0,19	—0,19	— 44,09
		+1099,34	+12,85	—3,96	+201,57	—31,23	+2,74	+21,81	—1,01	+0,43	+203,20
30. April—26. Mai	a	+ 291,18	—25,38	+1,16	— 52,48	— 0,91	—0,16	+ 2,14	+0,69	+0,01	— 73,11
	b	+ 920,77	+ 4,70	+0,43	+ 3,79	+ 0,14	+1,57	+ 6,52	+1,71	+0,11	+ 18,97
	c	+1837,22	+ 3,37	+3,70	+ 6,74	+ 0,31	—0,07	— 1,16	+3,62	—0,09	+ 16,42
		+3049,17	—17,31	+5,29	— 41,95	+ 1,36	+1,34	+ 7,50	+6,02	+0,03	— 37,72
26. Mai—18. Juni	a	+1965,16	+50,50	+3,71	+ 78,50	+ 7,06	+1,21	— 0,09	+0,20	+1,45	+142,54
	b	— 143,67	+ 8,15	+0,47	— 6,73	+ 0,94	—1,36	— 3,70	—1,06	+0,47	— 2,82
	c	— 474,23	+31,87	+2,00	— 2,58	+ 8,48	—2,29	—24,65	—7,92	+1,27	+ 6,18
		+1338,26	+90,52	+6,18	+ 69,19	+16,48	—2,44	—28,44	—8,78	+3,19	+145,90
18. Juni—11. Juli	a	—1693,76	—52,20	—5,05	— 34,74	— 6,65	—0,04	— 2,04	+0,09	—1,16	—101,79
	b	—1032,96	—16,92	—0,22	+ 5,66	+ 0,15	—0,19	— 4,83	—1,18	—0,63	— 18,16
	c	+1104,89	—18,38	—1,27	+ 3,27	+ 5,46	+1,71	+21,94	+4,64	—1,07	+ 16,30
		—1621,83	—87,50	—6,54	— 25,81	— 1,04	+1,48	+15,07	+3,55	—2,86	—103,65
11. Juli—12. August	a	— 393,83	—16,00	—1,02	— 60,12	— 2,12	—1,89	— 0,50	—0,13	—0,32	— 82,10
	b	+ 378,74	+ 3,23	+0,97	+ 0,19	+ 0,51	+0,44	— 0,07	+0,51	—0,01	+ 5,77
	c	— 184,63	— 6,42	+1,38	— 3,07	— 5,36	+0,79	— 7,74	—0,23	—0,32	— 20,97
		— 199,72	19,19	+1,33	— 63,00	— 6,97	—0,66	— 8,31	+0,15	—0,65	— 97,30
12. August—17. September	a	+ 16,46	+19,52	—0,16	— 4,77	— 0,27	—0,26	+ 0,09	+0,19	—0,01	+ 14,33
	b	+ 407,02	+ 4,14	—0,48	— 0,41	+ 0,68	+0,12	+ 0,07	+0,21	+0,03	+ 4,36
	c	—2128,00	—14,68	—2,21	— 9,91	— 8,55	—2,91	— 3,60	—3,25	—0,54	— 45,65
		—1704,52	+ 9,54	—2,85	— 15,09	— 8,14	—3,05	— 3,44	—2,81	—0,52	— 26,96
17. September—22. Oktober	a	— 475,87	—20,51	—1,65	— 30,58	— 0,51	—0,71	+ 0,01	—0,11	—0,15	— 54,21
	b	+ 734,33	+16,02	+0,47	+ 5,69	+ 1,65	+1,08	+ 3,35	+1,37	+0,08	+ 29,71
	c	— 299,44	+22,79	—0,77	— 4,25	+ 2,95	—0,49	— 7,62	—1,47	+0,06	+ 11,20
		+ 40,98	+18,30	—1,95	— 29,14	+ 4,09	—0,12	— 4,26	—0,21	—0,01	— 13,30

a: oberirdische lebende Fraktion b: oberirdische stehende, abgestorbene Fraktion c: unterirdische Fraktion

Tabelle 8

Austauschverhältnis der Elemente (%)

Fraktion	N	P	K	Ca	Mg	Fe	Mn	Na	Phytomasse
					1974				
Oberirdisch lebend	58,6	64,5	77,8	82,2	79,6	89,2	81,1	78,3	84,8
Oberirdisch abgestorben	53,3	46,1	45,4	57,8	47,3	84,5	69,1	65,3	51,2
Unterirdisch	39,9	44,7	35,9	55,2	34,1	40,2	55,0	41,0	35,1
					1975				
Oberirdisch lebend	70,7	73,4	87,6	78,2	72,2	83,4	79,5	87,3	83,4
Oberirdisch abgestorben	56,7	49,2	60,9	51,4	55,9	77,4	66,9	74,2	54,6
Unterirdisch	27,8	39,9	37,8	51,3	28,6	64,0	59,4	60,4	30,0

Der April des Jahres 1975 soll hervorgehoben werden, da eine so starke K-Fixierung stattfand (189,42 g/ha/Tag), daß diese die Gesamtelementaufnahme der krautigen Pflanzen zu jedem beliebigen Zeitpunkt beider Untersuchungsperioden übertrifft wird. In den oberirdischen lebenden Teilen verhält sich die Zunahme von P, Ca und Mg ähnlich und zwischen den in den beiden Jahren gemessenen Werten bestehen keine so großen Unterschiede wie bei N und K. Die Fixierung von P, Ca und Mg dieser Fraktion bewegte sich zwischen 1 und 5 g/ha/Tag. Etwas niedriger ist die Fe- und Mn-Fixierung und erreicht meist nicht den Wert von 1 g/ha/Tag. Die Zunahme ist bei Na am niedrigsten und lag in beiden Untersuchungsjahren zumeist unter 0,6 g/ha/Tag.

Im Falle der unterirdischen Fraktion konnten ähnlich der lebenden ebenfalls im Frühjahr die höchsten positiven Produktionswerte sowie die höchste Nährstoffixierung beobachtet werden. 1974 konnte die höchste tägliche Phytomassen- bzw. Nährstoffzunahme im April, 1975 dagegen im März nachgewiesen werden. 1974 betrug die Produktion +3039,82 g/ha/Tag, die Nährstoffixierung 82,85 g/ha/Tag, 1975 dagegen die Produktion +2517,47 g/ha/Tag und die tägliche Nährstoffzunahme 56,90 g/ha.

Zum Nährstoffverlust der unterirdischen Phytomasse kommt es hauptsächlich gegen Sommerende und im Herbst, so konnte zu den genannten Zeitpunkten z. B. 1974 ein maximaler Elementverlust von —17,10 g/ha/Tag und 1975 von —45,65 g/ha/Tag festgestellt werden. In der unterirdischen Phytomasse war die N-Fixierung während der Vegetationsperiode am höchsten und die N-Zunahme erreichte zumeist die der oberirdischen lebenden.

Die Produktionswerte der abgestorbenen oberirdischen Fraktion sowie die Werte, die die im Nährstoffgehalt einsetzenden täglichen Veränderungen anzeigen, sind im Gegensatz zu den vorangegangenen beiden Fraktionen zu Beginn der Wachstumsphase negativ, zu Ende des Sommers und im Herbst

dagegen positiv, damit anzeigend, daß im Frühjahr die noch stehenden abgestorbenen Teile auf den Boden gelangten und im Herbst intensive Absterbeprozesse der oberirdischen lebenden Teile einsetzen.

Wie erwähnt wurde, sind im Vergleich zu den oberirdischen lebenden und unterirdischen Fraktionen für die oberirdischen abgestorbenen Teile geringere Veränderungen während der Vegetationsperiode charakteristisch. Bei dieser Fraktion wurden auch im absoluten Wert 1000 g/ha/Tag überschreitende Veränderung zeigende Ergebnisse nur in zwei Fällen gefunden, im August 1974 (+1035,15 g/ha/Tag), was zu einem Phytomassenmaximum Anfang Oktober führte und im Juni 1975 (—1032,96 g/ha/Tag), was wiederum das Jahresminimum von oberirdischer abgestorbener Phytomasse zum Ergebnis hatte. Die Werte für Nährstoffaufnahme bzw. -verlust der Fraktion sind meist um eine Größenordnung niedriger als die für die beiden vorangegangenen Fraktionen charakteristischen Werte. Ein Vergleich der täglichen Elementzunahme in der oberirdischen abgestorbenen Phytomasse erlaubt die Feststellung, daß in diesem Falle kein Element eine besonders auffallende Rolle spielt, allein die tägliche N-Zunahme übersteigt die übrigen Elemente.

Austauschverhältnis und -zeit der Elemente

Über den Nährstoffhaushalt der Phytomassenfraktionen ist bei Untersuchung des Austauschverhältnisses (turnover rate) der verschiedenen Elemente (COLLIER et al. 1973, PRÉCSÉNYI 1972) ein annäherndes Bild zu gewinnen.

Für die Vegetationsperioden 1974 und 1975 wird das Austauschverhältnis der Elemente in Prozent nach Fraktionen unter Angabe der turnover rate in Tab. 8 angegeben. In beiden Jahren nahmen die für die Phytomasse und die Elemente berechneten Austauschverhältnisse in der Reihenfolge oberirdisch lebend, oberirdisch abgestorben und unterirdisch ab und erreichten nicht 100%, was auch verständlich ist, denn diese krautigen Pflanzen übernehmen als Mehrjährige bedeutende Mengen Phytomasse und gleichzeitig damit Elemente in die nächste Vegetationsperiode. Bei den oberirdischen abgestorbenen Teilen ist dies auch zu beobachten, oberirdischen abgestorbenen Teilen ist dies auch zu beobachten, nicht nur bei den lebenden Teilen, weil die abgestorbenen Pflanzenteile lange Zeit stehenbleiben und nur allmählich auf den Boden gelangen.

In den oberirdischen lebenden Teilen ist das Austauschverhältnis eines jeden Elements höher als 50% und kann sogar 90% erreichen. Das für die Phytomasse erhaltene Austauschverhältnis wird nur von einigen Elementen übertroffen wie z. B. in beiden Jahren von Fe (89,2 bzw. 83,4%), 1975 von K (87,6%) und Na (87,3%). Unter den Elementen sind N und P hervorzuheben, deren Austauschverhältnis am niedrigsten ist, bei N z. B. 1974 58,6%, 1975 70,7%. Die für beide Jahre berechneten turnover rates weichen bei N, K, P und Na stärker voneinander ab; die Werte des Jahres 1975 sind um 10% höher.

In den unterirdischen Teilen wurde für N, K und Mg ein niedriges turnover-Verhältnis (unter 40%) erhalten, besonders hoch ist beispielsweise

das Austauschverhältnis von Ca und Fe, so das von Ca 1974 55,2%, 1975 das von Fe 64,00%. Niedriger als das Austauschverhältnis der Phytomasse (35,1 bzw. 30,0%) war 1974 lediglich das von Mg (28,6%) und N (27,8%).

In den oberirdischen abgestorbenen Teilen schwankt das Austauschverhältnis der Elemente zwischen 45 und 85%. In beiden Jahren wurde das höchste Austauschverhältnis bei Fe festgestellt (84,5 bzw. 77,4%). Niedriger als das Austauschverhältnis der Phytomasse (55,2 bzw. 54,6%) war 1974 das von P, Mg und K, 1975 lediglich das von P.

LITERATUR

Collier, B. D.—Cox, G. W.—Johnson, A. W.—Miller, Ph. C. (1973): Dynamic ecology. Prentice-Hall, Englewood Cliffs, N. J. 429—489.

Duvigneaud, P. (1974): La synthèse écologique. DOIN, Paris.

Duvigneaud, P.—Deneayer, S.—Ambroes, P.—Timperman, J. (1971): Recherches sur l'écosystème forêt. Bruxelles.

Epstein, E. (1972): Mineral nutrition of plants: principle perspectives. J. Wiley, New York—London.

Ignat'eva, L. A. (1971): Accumulation of organic matter, mineral elements and nitrogen in the grass cover in some forests in the Ob-river region. In: Biological productivity and mineral cycling in the terrestrial plant communities (Bazilevich, N. I., Rodin, L. E. ed.). Nauka, Leningrad (in Russian). 258—267.

Jakucs, P. (1973): »Síkfőkút Project«. Egy cseres-tölgyes ökoszisztéma környezetbiológiai kutatása a Bioszféra-program keretén belül. (Síkfőkút-Project. Umweltbiologische Forschungen in einem Quercetum petraeae-cerris — Ökosystem im Rahmen des Biosphären-Programms.) MTA Biol. Oszt. Közl., **14**, 11—25.

Jakucs, P.—Papp, M. (1974): Production investigations of the undergrowth (herbaceous layer) of a Quercetum petraeae-cerris forest ecosystem. Acta Bot. Acad. Sci. Hung., **20**, 295—308.

Kolek, J.—Fulajtár, I. (1970): Dynamic of nutrients within the herb layer. Res. Project BÁB Progr. Rep. I. Slovak Acad. Sci., Bratislava. 99—101.

Mengel, K. (1968): Ernährung und Stoffwechsel der Pflanze. Fischer, Jena.

Mészáros, I. (1977): Bioelement content of herbaceous plants in a Quercetum petraeae-cerris forest ecosystem. Acta Biol. Debrecina, Debrecen. **14**, 21—27.

Nagy, L. (1978): Climatic characterization of sample area. In: Jakucs, P. (szerk.): Studies on the oak forest ecosystems of the Pannonicum. Results of »Síkfőkút Project« I. (manuscript)

Neshatayev, Yu. N.—Rastorova, O. G.—Schastnaya, L. S.—Tereshenkova, I. A.—Tryplenkov, V. P. (1966): Entry into the soil of ash elements and nitrogen with leaf fall from tress and grasses in the main types of oak stands in the »Forest on the Vorkskla«. Soviet Soil. Sci., 12: 1372—1379.

Ovington, J. D. (1962): Quantitative ecology and woodland ecosystem concept. Advan. Ecol. Res., Acad. Press, New York. **1**, 103—203.

Papp, M. (1978): Phytomass and production of the herb layer. In: Jakucs, P. (szerk.): Studies on the oak forest ecosystems of the Pannonicum. Results of »Síkfőkút Project« I. (manuscript)

Précsényi, I. (1972): Természetes terresztris ökoszisztémák primer produkciója. (Primärproduktion natürlicher terrestrischer Ökosysteme.) Diss. für Doktor. Biol. wiss. Vácrátót. Mskr.

Ramani, S.—Kannan, S. (1975): Manganese absorption and transport in rice. Physiol. Plant., **33**, 133—137.

Remezova, G. L. (1971): Role of grass cover in mineral cycling in the oak forest. In: Biological productivity and mineral cycling in the terrestrial plant communities (Bazilevich, N. I., Rodin, L. E., ed.). Nauka, Leningrad (in Russian). 241—245.

Rodin, L. E.—Bazilevich, N. L. (1967): Production and mineral cycling in terrestrial vegetation. Oliver and Boyd, Edinburgh—London.

Ulehlová, B.—Klimo, E.—Jakrlová, J. (1975): Mineral cycling in alluvial forest and meadow ecosystems in southern Moravia. XII. International Bot. Congr., Leningrad.

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BRYOPHYTES DE SRI LANKA (CEYLAN) III. COLOLEJEUNEA CEYLANICA ONR. ET COLOLEJEUNEA HINIDUMAE ONR., ESPECES NOUVELLES

Par

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(Arrivée le 19 septembre 1978)

Continuant l'inventaire des Hépatiques récoltées dans l'île de Ceylan, l'Auteur a reconnu deux *Cololejeunea* paraissant nouveau pour la science: *Cololejeunea ceylanica* Onr. et *Cololejeunea hinidumae* Onr.

Cololejeunea ceylanica Onraedt sp. nov. (Fig. 1)

Planta magnitudine media, nitens, foliicola, substrato subappressa. Caulis pallidus, cca 61–75 μm crassus, ad 2 cm longus, cum foliis cca 1890 μm latus, irregulariter pennatis, sectione transversali ex 5 cellulis corticalibus et 1 medullari exstructus et rhizoidibus pallidis fasciculatis apice furcatis affixus. Folia caulina contigua, decurvato-disticha, oblique patula dorso caulem tegentia, subelliptica, basi angustissime inserta, apice subrotundata; margo dorsalis e basi arcuatis irregulariterque dentatis, ventralis undulatis; 680–700 μm longa, cca 432 μm lata. Cellulae chlorophyllosae, hexagonae, apicales 22 × 17, medianae 37 × 28 μm, basales multo longiores cca 50 × 22 μm metientes; ubique parietibus aequaliter incrassatis, trigonis minutis, cuticula laevi. Ocelli nulli. Lobulus maiusculus, ellipticus, folio subtriplo brevior, 700 μm longus et 430 μm latus, brevissimo insertus, basi leviter inflatus; carina leviter arcuata in parte superiore dentata, apice truncatus, oblique emarginatus bidentatus, dente angulari unicellulari, mediano bicellulari, papilla basali notata. Stylus in basi lobuli hyalinus filiformis, ex 5–6 cellulis in una serie dispositis, ad 155 μm longus. Gemmae haud numerosae, regulariter disciformae, in statu 24 cellulari os 72 μm in diametro. parte mediana 4 cellulari. Androecia non visa. Gynoecia in ramis lateralibus brevibus uno latere innovata; folia involucralia perianthiis subduplo breviora, oblonga, apice leviter angustata et irregulariter dentata, lobulo simili ad medium soluto subduplo minore. Perianthia e basi angusta late obcordata, folia caulina vix superantia, cca 810 μm longa ad 570 μm lata, compressa, 4-plicata plicis posticis dentatis in unam latam confluentibus, lateralibus acute carinatis, ambitu rotundatis dupliciter dentatis, rostro valide. Capsula elateribus aspiris parietibus incrassatis et sporis intense papillatis.

Sri Lanka: Galle district, Hiniduma, Kanneliya Forest Reserve, forêt dense, ombrophile, alt. ca 150 m, le 16 août 1977, coll. ONRAEDT No. 77.L.4191 (Holotypus in Hb. ONRAEDT, isotypi in JE, EGR, NICH); No. 77.L.4060 (Paratypi in Hb. ONRAEDT, JE); No. 77.L.4254 (Paratypi in Hb. ONRAEDT, EGR, JE).
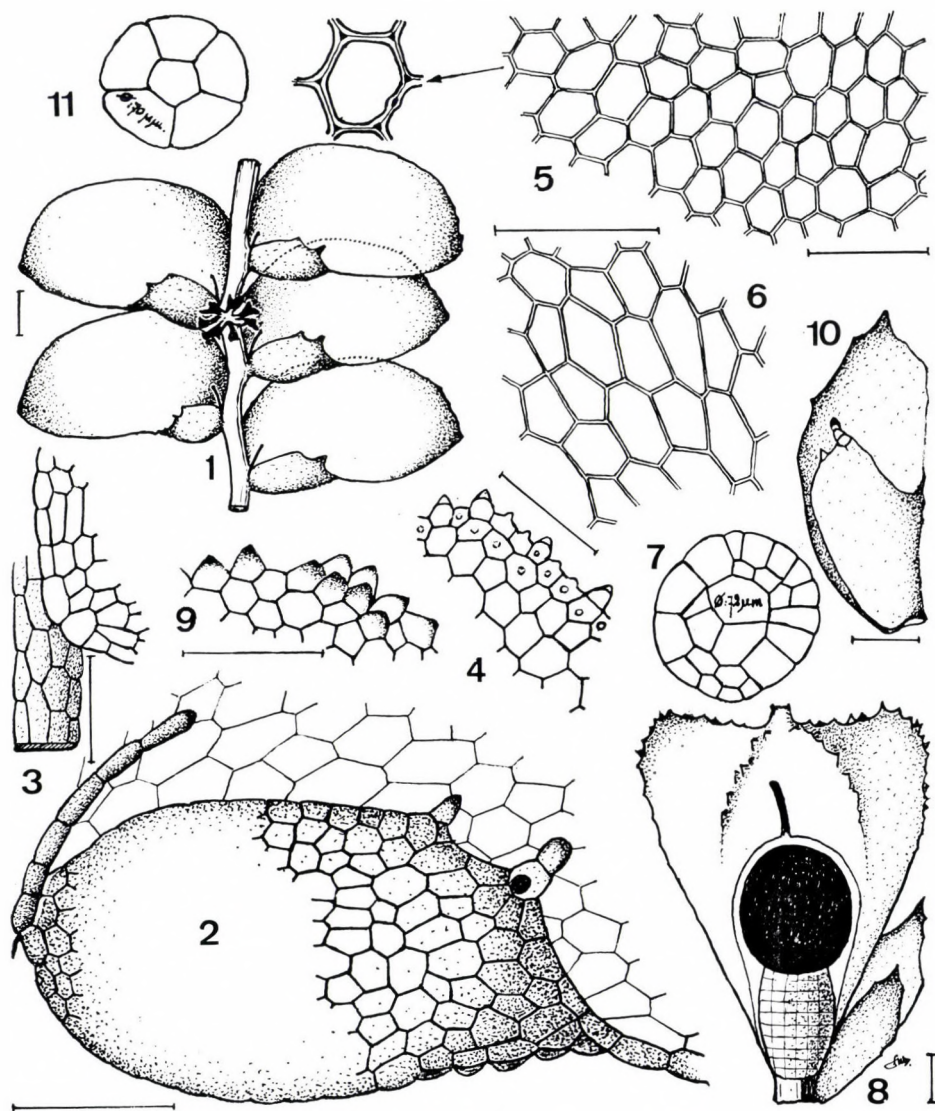
Fig. 1. Cololejeunea ceylanica Onraedt sp. nov. (No. 77.L.4191). 1. segment de tige feuillée, vue ventrale; 2. lobule et stylet; 3. insertion de la feuille sur la tige, vue dorsale; 4—6. tissu foliaire apical, central, basal; 7. propagule disciforme; 8. périanthe et bractée fémelle; 9. tissu apical du périanthe; 10. coupe transversale de la tige. (Segments de droite: 100 μm)

Observations: Par sa papille hyaline située à la base de la dent apicale, ses lobules ovales enflés à la base et la marge foliaire dorsale denticulée, *Cololejeunea ceylanica* doit être rangé dans le subg. *Lasiolejeunea* Benedix ou bien dans le subg. *Platycolea* Schuster. Par son style filiforme, l'espèce nouvelle fait penser a *C. goebelii* Schiffn. Elle s'en écarte, en particulier, par son tissu

foliaire (absence de trigones et membranes uniformément épaissies), son périanthe à 5 carènes dentées bien développées et ses propagules disciformes à marge non crénelée.

Notre espèce se distingue également des *Cololejeunea denticulata* et *C. fridericii* qui tous deux ont des styles unicellulaires.

Tabelle 1

Comparaison de Cololejeunea ceylanica Onraedt avec 3 Cololejeuneas affines (d'après H. Mizutani in litt.)

	C. gottschei	*C. goebelii* (so called)	*C.ceylanica*	*C. nymanii* (after BENEDIX)
Perianth				
Lateral keel	not so winged generally smooth	not so winged generally smooth	winged, denticulate	winged, denticulate
Dorsal surface	smooth	smooth	somewhat papillose	papillose
Ventral surface			with 2 denticulate ridges	
Stylus	unicellular	multicellular	multicellular	unicellular
Leaf-cell				
Walls	thin	thin	rather thick	rather thick
Trigones and intermediate thickenings	small, but distinct	small, but distinct	indistinct	indistinct
Dorsal papillae	absent	on marginal cells	on marginal cells	on most cells
Foundation of 1st tooth of leaf lobule	not exaggerated	exaggerated	exaggerated	exaggerated
Leaf apex	apiculate	rounded	apiculate	rounded

Cololejeunea hinidumae Onraedt sp. nov. (Fig. 2)

Planta magnitudine media, pallide viridis, epiphylla ad folia adhaerentia. Caulis cca 97 μm crassus, cum merophytis uni- vel biseriatis, ad 2 cm longus, cum foliis cca 2160 μm latus, irregulariter ramosus. Folia caulina parum imbricata, caulem superantia; lobus asymmetricus, margine antico bene arcuato postico substricto, ovato-reniformis, integer, basi brevissima inserta, cca 1215×729 μm, apice rotundata et 1-serie cellularum hyalinarum quadrangularum marginata; lobulus parvulus triangulariformis, planus, carina leviter arcuata, dente apicali 1—2 cellulari obtuso, papilla hyalina apicali. Stylus in basi lobuli unicellularis, hyalinis. Gemmae disciformae e ±26 cellulis compositae. Cellulae foliares polygonales chlorophyllosae, submarginales cca 21.6×18 μm, centrales ad 36×29 μm, basales 79×18 μm, parietibus trigonis nodulisque magnis; cuticula laevis. Androecium lateralium, 2—3-jugatum. Gynoecium in apice rami lateralis brevis dispositum; innovatio 1. Bracteae erectae quam folia vegetativa minores. Perianthium exertum, cca 975×674 μm, obcordatum, compressum, bialatum, in marginibus $\pm$ crenulatis, carina ventralis rotundata.
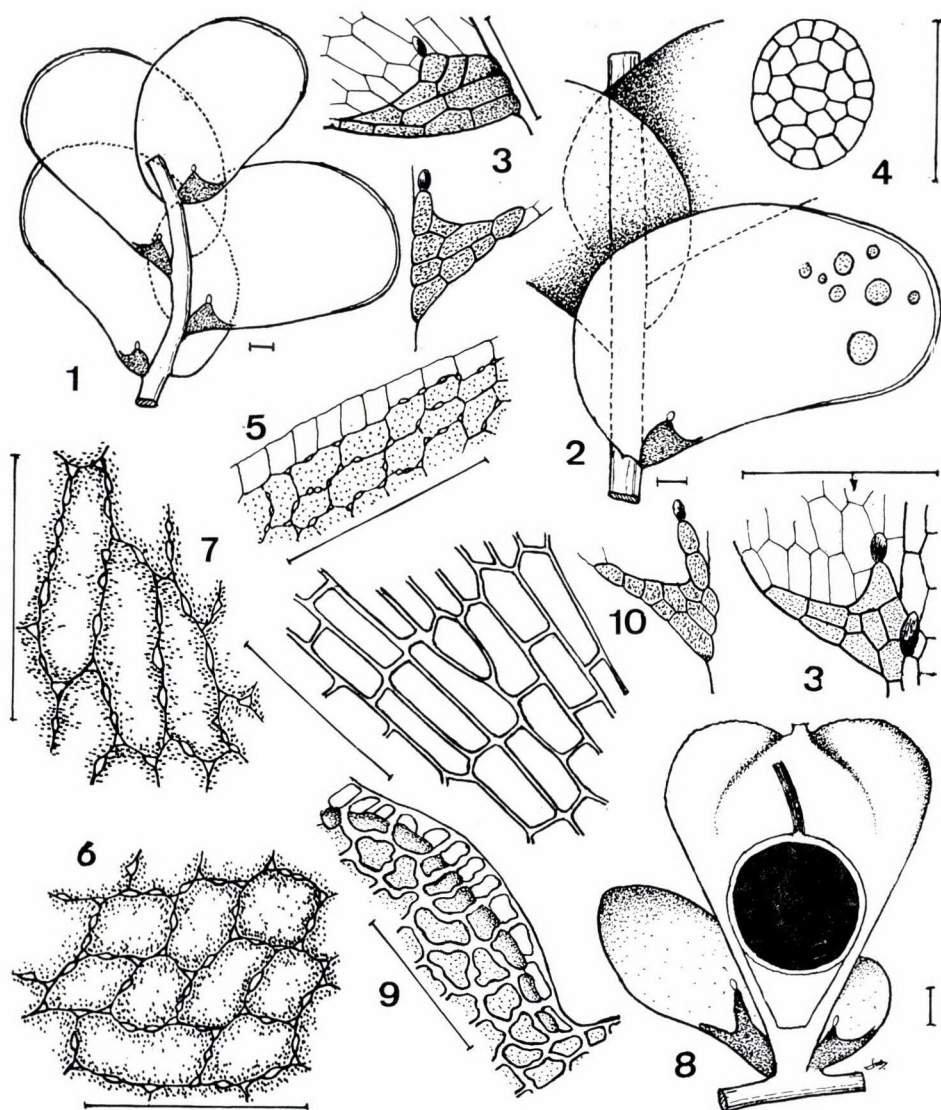
Fig. 2. Cololejeunea hinidumae Onraedt sp. nov. (No. 77.L.4260). 1. segment de tige feuillée, vue ventrale; 2. insertion des feuilles sur la tige, vue dorsale; 3. lobules; 4. propagule disciforme; 5—7. tissu foliaire apical, central, basal; 8. périanthe et bractées femelles; 9. tissu apical du périanthe; 10. tissu basal du périanthe. (Segments de droite: 100 μm)

Sri Lanka: Galle district, Hiniduma, Kanneliya Forest Reserve, alt. 150 m, le 19 août 1977, coll. M. ONRAEDT No. 77.L.4266 (Holotypus in Hb. ONRAEDT, isotypus in JE).

Observations: Par ses feuilles chlorophylleuses fortement appliquées contre le substrat et bordées de cellules hyalines, ses lobules comprimés et

triangulaires et ses périanthes aplatis, la nouvelle espèce appartient au subgen. *Pedinolejeunea* Benedix.

Elle diffère par ses lobules plans, ses cellules hyalines unisériées et son périanthe obcordé de *Cololejeunea planissima*, espèce asiatique. Elle semble plus proche de *Cololejeunea jonesii* Pócs, espèce africaine, qui a également un lobule plan, triangulaire, une marge hyaline formée par des cellules unisériées, un périanthe subcordé et les mérophytes ventraux formés par deux séries de cellules. Mais chez *C. jonesii* la marge anticale du lobule n'est pas arqué, les cellules n'ont pas de trigones et d'épaissements intermédiaires, la papille hyaline est subapicale, non apicale sur le lobule, enfin, les propagules sont formés par 40—50 cellules. Toutes les dimensions de *C. hinidumae* sont plus grandes.

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L'auteur voudrait exprimer sa gratitude aux Drs. R. Grolle, H. Inoue, M. Mizutani et T. Pócs, qui ont désigné ces deux *Cololejeunea* comme était, sans doute, des espèces nouvelles et les ont comparés avec les espèces affines.

BIBLIOGRAPHIE

Bonner, C. E. B. (1963): Index Hepaticarum IV: Ceratolejeunea to Cololejeunea. Weinheim 634—926.

Mizutani, M. (1961): A revision of Japanese Lejeuneaceae. Journ. Hattori Bot. Lab. **24**, 115—302.

Onraedt, M. (1968): Bryophytes de Sri Lanka (Ceylan) I—II. Frullania perocellata Onr., Cololejeunea fredericii Onr. Rev. Bryol. et Lichén. **44**, 77—82.

Pócs, T. (1975): New or little known epiphyllous liverworts I. Cololejeunea from tropical Africa. Acta Bot. Acad. Sci. Hung. **21**, 353—375.

Schuster, R. M. (1963): An annotated synopsis of the genera and subgenera of Lejeuneaceae. I. Beihefte zur Nova Hedwigia **9**, 203 pp.

Tixier, P. (1970): Contribution à la connaissance du genre Cololejeunea en Asie du Sud-Est II. la section Radulae (nov. sect.) du sous-genre Lasiolejeunea. Ann. Fac. Sc. Pnom Penh 1970, 177—190.

Tixier, P. (1977): Lejeuneaceae from Sri Lanka Collected by D. D. Tirvengadum (1974). Ceylon J. Sci. (Bio. Sci.) **12**, 85—88.

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DIE NETTOPRODUKTION DER BÄUME EINES QUERCETUM PETRAEAE-CERRIS-WALDES AUF DER PROBEFLÄCHE VON SÍKFŐKÚT (NORD-UNGARN)*

Von

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Vorliegende Arbeit teilt die Nettoproduktion der Baumarten *Quercus petraea* und *Quercus cerris* eines ungarischen Eichenwaldes mit. Die Jahresproduktion der Komponenten beider Arten (Laub, Äste und Zweige, Stamm, Wurzel) wurde durch wiederholte, im Abstand von fünf Jahren erfolgte Phytomassen Aufnahme und Jahresringanalyse bestimmt. Zur Berechnung des Trockengewichs der Bäume wurden Regressionen zwischen Gewicht und Grösse (Komponentengewicht, Stammdurchmesser) verwendet. Neben den lebenden Komponenten wurde auch die Streu Produktion der verholzten Komponenten geschätzt und die jährliche Stoffbilanz der Phytomasse berechnet.

Anhand der durchgeführten Untersuchungen beträgt die jährliche Nettoproduktion der beiden genannten Baumarten 10,784 t/ha Trockensubstanz. Diese Menge enthält auch die von Raupen vernichtete Laubmenge, die zwischen 1972 und 1976 bei *Quercus petraea* im Durchschnitt 1316,2 kg/ha, bei *Quercus cerris* dagegen 29,9 kg/ha jährlich betrug (24,6% bzw. 5,1% Raupenfrass). Den grösseren Teil der jährlichen Nettoproduktion der Baumschicht, 71,4%, stellt den Mischungsverhältnissen entsprechend die Produktion von *Quercus petraea* (7703 kg/ha) dar. Der Gesamtproduktion von *Quercus cerris* kommt ein Anteil von 3080,8 kg/ha (28,6%) zu. Die Produktion der Baumschicht liegt bei 5,2 g/m²/Tag.

53,5% (5765 kg/ha) der Nettoproduktion der Bäume ergeben sich aus der Laubproduktion. Von der Messbaren, mit dem Gewicht der Raupenschäden nicht korrigierten Laubmenge (4418,9 kg/ha) gelangten jährlich 84,2% (3722,8 kg/ha) in Form von Streu auf die Bodenoberfläche. 43,4% (4684 kg/ha) der Nettoproduktion werden von der jährlichen Gewichtszunahme der verholtzen Komponenten (Äste und Zweige, Stamm, Wurzel) gebildet, während die Menge von Frucht und Blüte 3,1% ausmacht. Die jährliche Produktion an toter Holzmasse (abfallende Zweige und zugrundegegangene Bäume) beträgt 1782 kg/ha, d. h. in den verholzten Komponenten der Bäume werden jährlich 2902 kg/ha organisches Material gespeichert.

Aus den Untersuchungen geht hervor, dass der grössere Teil (5839,6 kg/ha) der jährlichen Nettoproduktion auf die Bodenoberfläche zurückgelangt gegenüber einer geringeren Menge (2902 kg/ha), die in den verholzten Teilen gespeichert wird. In die Jahresbilanz der Phytomasse wurde das Gewicht nicht einbezogen (696,1 kg/ha), das vor dem Laubfall vom grünen Laub teilweise in die verholzten Teile zurückkehrt und teilweise auf die Bodenoberfläche gelangt.

Einleitung

Unsere Untersuchungen schliessen sich an die vom Lehrstuhl für Botanik der Lajos-Kossuth-Universität Debrecen im Jahre 1972 begonnenen Ökosystemforschungen (Síkfőkút-Project, JAKUCS 1973) an. In der ersten Untersuchungsphase wurde die Phytomasse der

* Síkfőkút-Project Nr. 45.

Baumschicht des Eichenwaldes aufgenommen (PAPP, B. 1974), in der zweiten Phase die jährliche Nettoproduktion der Bäume bzw. die jährliche Stoffbilanz der Baumschicht berechnet und hier mitgeteilt.

Der untersuchte Wald ist ein 65—70jähriger klimazonaler *Quercetum petraeaea-cerris*-Wald, der sich im südwestlichen Teil des Bükk-Gebirges in der Nähe der Stadt Eger in einer Höhe von 300 m. ü. M. auf Braunerde befindet. Die Baumschicht wird von zwei Arten im Verhältnis 84,6% (*Quercus petraea*) und 15,4% (*Quercus cerris*) gebildet. Die Baumzahl beträgt 816 Stück/ha, die Deckung der Laubkronenschicht 80%. Eine ausführlichere Beschreibung von Gebiet und Vegetation ist bei JAKUCS 1973, JAKUCS, HORVÁTH und KÁRÁSZ 1975, PAPP und JAKUCS 1976 zu finden.

Methoden

Eine Methode zur Schätzung der Produktion der oberirdischen verholzten Komponenten war die wiederholte Messung der Phytomasse. Dazu wurden 1972, dann 1977, also nach fünf Jahren auf einer Fläche von 50 × 100 m der 1 ha grossen Probefläche der Stammumfang aller Bäume in einer Höhe von 1,3 m über der Erdoberfläche gemessen. Aus den Stammumfängen wurden die Stammdurchmesser berechnet. Unter Verwendung der im Jahre 1972 aufgestellten Regressionen zwischen dem Trockengewicht der Komponenten der Probebäume (Laub, Äste und Zweige, Stamm) und dem Stammdurchmesser (PAPP, B. 1974) wurde das Trockengewicht der Komponenten aller Bäume der 0,5 ha grossen Fläche berechnet. Anschliessend wurden die Ergebnisse auf 1 ha bezogen. Es soll bemerkt werden, dass für die Wurzeln solche Regressionen nicht berücksichtigt wurden; deren Gewicht/ha wurde deshalb sowie 1972, wie auch 1977 nach SOPP (1974) geschätzt. Anhand des in beiden Untersuchungsjahren bestimmten Phytomassenunterschiede wurde der in den fünf Bezugejahren erfolgte mittlere Zuwachs dieser Bäume geschätzt.

Zur Berechnung der Jahresproduktion der oberirdischen verholzten Komponenten wurde auch eine andere oft benutzte Schätzungsmethode, die sog. Jahresringanalyse verwendet. Dazu wurden Anfang September 1977 10 Exemplare von *Quercus petraea* und 5 Exemplare von *Quercus cerris* mit einem mittleren Stammdurchmesser in 1,3 m Höhe mit einem Pressler-Baumbohrer entlang von vier Strahlen in vier Richtungen angebohrt und die Breite der letzten fünf Jahresringe im Mikroskop gemessen. Natürlich wurde auch der aktuelle (1977) Stammdurchmesser der Probebäume gemessen. Aus der Breite der fünf Jahresringe wurde der jährliche Zuwachs der Stammdurchmesser der Bäume bzw. der mittlere Stammdurchmesser von vor fünf Jahren berechnet, aus letzterem unter Verwendung der Regressionen zwischen Gewicht und Grösse weiterhin das Trockengewicht der Komponenten von vor fünf

Tabelle 1

Phytomasse von Quercus petraea und Quercus cerris

		Laub	Äste und Zweige		
			Holz	Bast	Gesamt
Quercus petraea	1972	3,427 (2,0%)	30,971	14,926	45,897 (26,5%)
	1977	3,723	34,022	16,396	50,418
Quercus cerris	1972	0,825 (1,9%)	6,106	3,586	9,692 (22,2%)
	1977	1,006	7,607	4,467	12,074
Gesamt	1972	4,252 (2,0%)	37,077	18,512	55,589 (25,6%)
	1977	4,729	41,629	20,863	62,492

Jahren. Die mittleren Jahreslaubproduktionen wurden einerseits aus dem 1972 mittels Regressionen berechneten Laubgewicht, andererseits aus den zwischen 1972 und 1976 jährlich gemessenen Laubproduktionsmengen berechnet. Dazu wurde das Verhältnis des Laubstreugewichts des Jahres 1972 zu der Streuproduktion der späteren Jahre Jahr für Jahr berechnet. Die auf diese Weise gewonnenen Verhältnisse wurden mit den 1972 gemessenen lebenden Laubgewichten multipliziert. Als Ergebnis erhielten wir die effektiv messbare Laubproduktion der einzelnen Jahre. Aus der Mittelbildung der Laubproduktionen der fünf Jahre sind die fünf diese Jahre gültigen mittleren Laubproduktionen ermittelt worden.

Ausser den tatsächlich messbaren Laubgewichten haben wir auch die durch das Gewicht des Raupenfrassen ergänzten, sog. rekonstruierten Laubproduktionen angegeben. Zu ihrer Berechnung (messbaren) Blattgewichte mit Hilfe der Raupenfrassprozente auf unversehrte Blattgewichte rekonstruiert. Die rekonstruierten Blattgewichte wurden aus dem Verhältnis des Frasses berechnet:

$$\text{Verhältnis des Frasses: } \frac{\text{rekonstruiertes} - \text{messbares Blattgewicht}}{\text{rekonstruiertes Blattgewicht}}$$

Nach der Multiplikation der rekonstruierten Blattgewichte mit den Blattzahlen je nach Hektaren — die aus den messbaren Laubproduktionen und aus den messbaren mittleren Blattgewichten berechnet wurden — haben wir die rekonstruierten Laubproduktionen erhalten. Der Unterschied zwischen diesen letzteren und der messbaren Laubproduktion ergab die von den Raupen konsumierten Laubmengen.

Die Menge der Früchte (Eicheln + Becher) und Blüten wurde aus den in die Streusammelkisten gefallenen Mengen bestimmt. Die Sammlung und Messung der fallenden Blüten und Früchte erfolgte in den Jahren 1973—1976 (s. Tóth, Papp, B. und Jakucs, Mskr.).

Zur Feststellung der Streuproduktion der verholzten Komponenten (Äste und Zweige, Stamm, Wurzel) wurde einerseits die Menge an zugrundegegangen Bäumen (noch stehende und umgestürzte), zum anderen die abgebrochenen dürren Ästen geschätzt. Zur Berechnung der Menge an jährliche zugrundegegangenen Bäumen wurde 1972 und 1977 deren auf 1 ha entfallende Phytomasse geschätzt. Aus dem Unterschied beider Phytomassen wurde der jährlichen Anteil der abgestorbenen Bäume an verholzten Komponenten berechnet. Zur Schätzung der herunterfallenden toten Holzmasse wurden Anfang 1975 drei 10×10 m grosse Vierecke gesäubert und zweimal jährlich die auf diese Fläche gefallenen Äste und Zweige gesammelt und gewogen. Die Ergebnisse wurden auf 1 ha bezogen und in Trockengewicht angegeben. Die Untersuchung wurde nach Chapman (1976) und Newbould (1970) durchgeführt.

in den Jahren 1972 und 1977 (Trockengewicht t/ha)

Stamm			Wurzel			Gesamt
Holz	Bast	Gesamt	Holz	Bast	Gesamt	
92,389	8,264	100,652 (58,0%)	18,477	4,971	23,448 (13,5%)	173,424 (100%)
99,552	8,904	108,456	20,031	5,389	25,420	188,017
24,606	2,673	27,280 (62,4%)	4,555	1,361	5,916 (13,5%)	43,713 (100%)
29,552	3,211	32,763	5,524	1,650	7,174	53,017
116,995	10,937	127,932 (58,9%)	23,032	6,332	29,364 (13,5%)	217,137 (100%)
129,104	12,115	141,219	25,555	7,039	32,594	241,034

Ergebnisse

Die Produktion der verholzten Komponenten

Die bei der Feststellung der Phytomasse die Berechnungsgrundlage bildenden Daten von 1972 und 1977 werden in Tabelle 1 mitgeteilt. Zur Berechnung des Trockengewichts der Komponenten wurden in jedem Jahr die Regressionen der Tabelle 2 verwendet. Die nach dieser Methode errechnete Produktion der Baumarten ist in Tabelle 3 enthalten. Anhand unserer Berechnungen beträgt die jährliche Gewichtszunahme der verholzten Komponenten beider Baumarten 4684 kg/ha (Trockengewicht). Ein grosser Teil davon ist in den oberirdischen Kom-

Tabelle 2

Regressionen zwischen Gewicht und Grösse für verschiedene Komponenten von Quercus petraea und Quercus cerris

Komponenten		A*	*b*	*r*	Sy	CV%	*n*
Laub	1.	−3,0000	2,8150	0,821	0,048	6,43	10
	2.	−3,0020	2,8410	0,734	0,128	7,06	5
Äste und Zweige	1.	−2,6370	3,3906	0,842	0,138	7,68	26
	2.	−2,3218	3,1315	0,952	0,056	2,87	8
Stamm	1.	−1,2827	2,6256	0,951	0,054	2,52	26
	2.	−1,1722	2,6100	0,945	0,042	1,78	8
Äste + Zweige und Stamm	1.	−1,3306	2,7898	0,973	0,042	1,80	26
	2.	−1,1983	2,7312	0,987	0,037	1,50	8
Laub + Äste und Zweige + Stamm	1.	−1,3205	2,7897	0,974	0,041	1,75	26
	2.	−1,1895	2,7300	0,982	0,029	1,43	8

Jede Regression liegt in der Form $\log y = \log a + b \log x$ vor, wobei y = Trockensubstanz der Komponenten (kg), x = Durchmesser in Brusthöhe (cm)
A* = log a und b Konstanten
r = Korrelationskoeffizient
Sy = rel. Fehler der Regressionsgerade
CV% = Variationskoeffizient
n = Anzahl der Wiederholungen

ponenten anzutreffen (4038 kg/ha), in den Wurzeln dagegen beträgt der jährliche Zuwachs insgesamt 646 kg/ha. Die Gesamtjahresproduktion der verholzten Anteile macht lediglich 2,1% der Phytomasse der verholzten Komponenten aus. Ein grosser Teil der Gesamtproduktion der verholzten Komponenten wird natürlich vom Stamm (56,7%), der kleinere Teil dagegen von der in den Zweigen (29,5%) bzw. Wurzeln (13,8%) akkumulierten Stoffmenge gebildet.

Der Anteil der verholzten Pflanzenteile beider Baumarten an der Gesamtproduktion weicht von deren Anteil an der Phytomasse ab. Die Produktion der verholzten Teile von *Quercus cerris* macht 39% der Holzproduktion beider Arten aus, deren Phytomasse stellt aber nur 21% der gesamten Phytomasse dar. Das ergibt sich einerseits daraus, dass der mittlere Stammdurchmesser der *Quercus cerris*-Exemplare wesentlich grösser und auch der Stammdurchmesserzuwachs höher ist (s. Tabelle 4). Dazu kommt, dass im Laufe von fünf Jahren 26 Exemplare von *Quercus petraea* vertrocknet sind, deren Gewicht selbstverständlich nicht in die lebende Phytomasse einbezogen wurde, während in diesem Zeitraum kein einziges Zerreichenexemplar vertrocknete.

Tabelle 3

Mittlere Nettoproduktion der Baumarten Quercus petraea und Quercus cerris (Trockengewicht kg/ha) Jahr zwischen 1972 und 1977

1. Angabe: mit Raupenfrase nicht korrigiertes Laubgewicht; 2. Angabe: korrigiertes Laubgewicht. Die Angaben in Klammern deuten das Ausmass des Ausmass des Raupenfrasses an.

		Laub	Äste und Zweige	Stamm	Wurzel	Gesamt	Frucht	Blüte
Quercus petraea	1.	3498,6	904,2	1560,8	394,4	6 386,8	—	28,8
	2.	4814,8				7 703,0		
		(1316,2)						
Quercus cerris	1.	920,3	476,4	1096,6	251,6	3 050,9	296,9	9,1
	2.	950,2				3 080,8		
		(29,9)						
Gesamt	1.	4418,9	1380,6	2657,4	646,0	9 437,7	296,9	37,9
	2.	5765,0				10 783,8		
		(1346,1)						

Wie oben bereits erwähnt, wurde zur Schätzung der Produktion der Bäume auch eine andere Methode, die sog. Jahresringanalyse benutzt. Nach diesen Messungen erhöhte sich der Stammdurchmesser von *Quercus petraea* in Brusthöhe (1,3 m) in fünf Jahren um jährlich 1,867 mm. Mehr also doppelt so hoch ist dagegen die mittlere Stammzunahme (4,036 mm/Jahr) bei *Quercus cerris* (s. Tabelle 4, Abbildung 1).

Grosse Abweichungen waren im Hinblick auf die mittleren Jahresringbreiten unter den untersuchten 10, bzw. 5 Probebäumen festzustellen. Bei *Quercus petraea* beträgt die aus fünf Jahresringem berechnete mittlere Jahresringbreite 1,867 mm, die Streuung der Daten (s) = 0,541, der Variationskoeffizient (CV%) = 29,2. Die gleichen Werte liegen bei *Quercus cerris* bei $s =$ $= 4{,}036 \pm 0{,}940$ und CV% = 25,3. Wesentlich stärker ist die Abweichung der Jahresringbreiten von diesen Werten in den einzelnen Jahren. Bei *Quercus petraea* beträgt die Streuung (s) = $1{,}867 \pm 0{,}676$ mm/Jahr (CV% = 36,2), bei *Quercus cerris* $4{,}035 \pm 1{,}778$ (CV% = 44,1). Die jährliche Stammdurchmesserzunahme zeigte in den untersuchten fünf Jahren Ähnlichkeit mit der jährlichen Veränderung der Laubstreumenge. Ähnlich wie die Laubstreumenge war die Stammdurchmesserzunahme im Jahre 1974 am niedrigsten (vgl. Tóth, B. Papp und Jakucs Mskr.).

Im Vergleich zur mit Hilfe wiederholter Aufnahmen geschätzten Phytomassenproduktion ist die anhand der Jahresringanalyse geschätzte Phytomasse bzw. die daraus berechnete Produktion höher. Bei *Quercus petraea* beträgt dieser Produktionsunterschied 8%. Wesentlich höher war die Abweichung bei *Quercus cerris*. Die nach Jahresringen berechnete Produktion übersteigt bei dieser Art die mit wiederholter Durchmessermessung erhaltenen Produktionswerte.
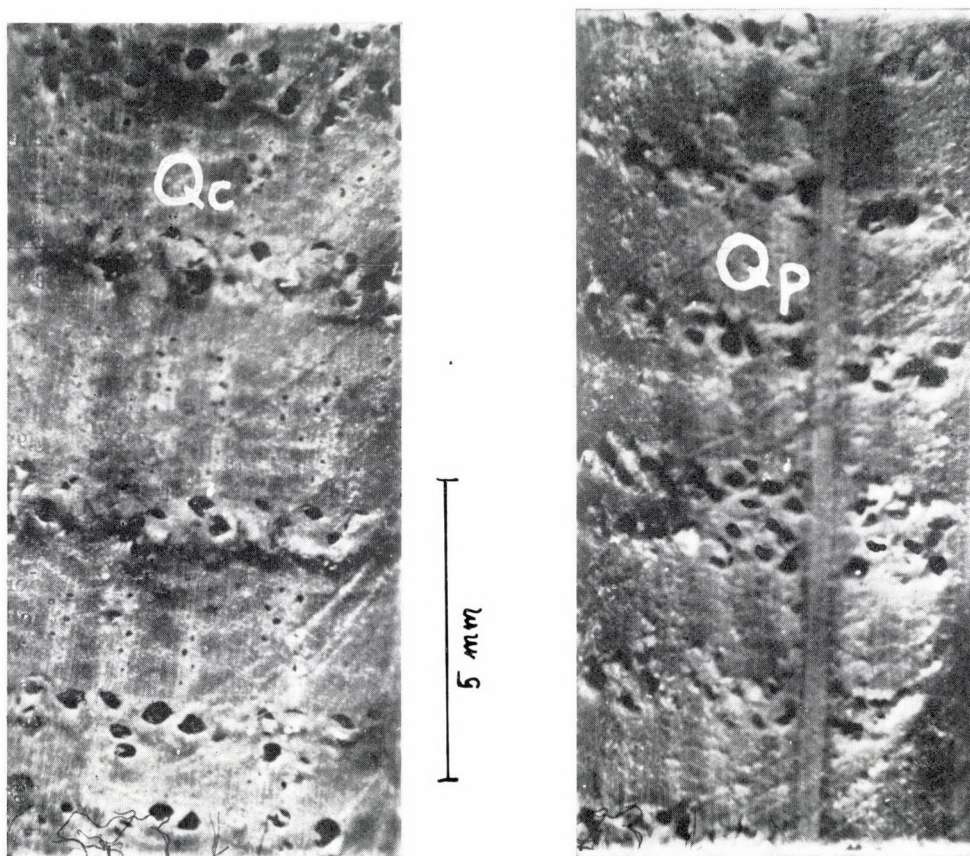
Abb. 1. Jahresringe von Quercus cerris (Qc) und Quercus petraea (Qp)

Laubproduktion

Die mittlere Jahreslaubproduktion der zwei Baumarten (1972—1976) macht 4418,9 kg/ha aus. Diese Menge ist die effektiv messbare, d. h. durch die von den Phytophagen konsumierten Menge nicht ergänzte Laubproduktion (in weiteren messbare Laubproduktion). Den grössten Teil der Laubproduktion — 79,8% — gibt, den Mischungsverhältnissen der zwei Arten entsprechend, das Laubgewicht von *Quercus petraea* (s. Tabelle 3).

Während der fünf Jahre zeigte sich in den messbaren Laubproduktionen ein grosser Unterschied. Die Menge der Laubproduktion bewegte sich in Falle von *Quercus petraea* zwischen 3217,6 und 3778 kg/ha, die Streuung der Laubgewichte (s) zeigte bei dieser Art 3498,6 $\pm$ 238,6 kg/ha (CV% = 18,4). Die messbare Laubproduktion von *Quercus cerris* bewegte sich in dieser Fünfjahrperiode zwischen 825 und 1114,9 kg/ha (s = 920,3 $\pm$ 169,1 kg/ha, CV% = = 18,4) (Tabelle 5).

Tabelle 4

Jährlicher nach Jahresringanalyse berechneter Stammdurchmesserzuwachs (in mm) von Quercus petraea und Quercus cerris zwischen 1973 und 1977
(In Klammern wurden die aktuellen Jahresringbreiten angegeben.)

		1977	1976	1975	1974	1973	Gesamt	Mittel mm/Jahr
Quercus petraea	mm/Jahr	2,492	2,024	2,498	1,072	1,248	9,334	1,867 ± 0,676
	cm	(21,66)	(21,41)	(21,21)	(20,96)	(20,85)		
Quercus cerris	mm/Jahr	6,533	3,879	4,704	1,689	3,375	20,180	4,036 ± 1,778
	cm	(24,03)	(23,38)	(22,99)	(22,52)	(22,35)		

Tabelle 5

Laubproduktion der Baumarten Quercus petraea und Quercus cerris zwischen 1972 und 1976 (Trockengewicht in kg/ha/Jahr)

Jahr	Messbares Blattgewicht* g/Blatt	rekonstruiertes Blattgewicht** g/Blatt	Raupenfrass*** %	Laubstreu, **** kg/ha/Jahr	messbare Laubproduktion, kg/ha/Jahr	rekonstrierte Laubproduktion kg/ha/Jahr	durch Raupenfrass verlorengegangenes Laubgewicht, kg/ha/Jahr
				Quercus petraea			
1972	0,0899	0,1487	40,0	2787,4	3427,0	5712,9	2285,9
1973	0,1713	0,2001	14,4	2731,1	3357,8	3922,3	564,5
1974	0,1690	0,2031	18,8	2617,2	3217,6	3866,8	649,2
1975	0,1054	0,1836	42,6	3075,5	3778,4	6582,1	28 3,5
1976	0,1614	0,1735	7,0	3019,1	3711,8	3990,0	278,3
Mittel	0,1393	0,1818	24,6	2845,7 ± 194,1	3498,6 ± 238,6	4814,8 ± 1255,5	1316,2
				Quercus cerris			
1972	0,1617	0,1702	5,0	786,2	825,0	868,4	43,4
1973	0,1163	0,1187	2,0	685,0	718,8	733,6	14,8
1974	0,1707	0,1760	3,0	826,9	867,7	894,6	26,9
1975	0,1422	0,1497	5,0	1062,6	1114,9	1173,8	58,8
1976	0,1617	0,1625	0,5	1024,6	1075,2	1080,5	5,3
Mittel	0,1505	0,1554	3,1	877,1	920,3 ± 161,1	950,2 ± 169,1	29,9

* Gerechnet anhand der Daten von PAPP, B. (1974), VIRÁGH (Mskr.), ANTAL (1978) ** Daten von TÓTH, PAPP. B. und JAKUCS (Mskr.)
*** Daten von VARGA und LAKATOS (Mskr.) **** Daten von TÓTH, PAPP. B. und JAKUCS (Mskr.)

Ausser den effektiv messbaren Laubproduktionen haben wir auch die durch die von den Phytophagen konsumierten Laubmengen ergänzten, sog. rekonstrierten Laubproduktionen berechnet. Das Jahresmittel von fünf Jahren der auf diese Weise ergänzten, rekonstruierten Laubproduktion betrug 5765 kg/ha (*Quercus petraea* 4814,8 kg/ha, *Quercus cerris* 950,2 kg/ha) (Tabelle 5). Den Änderungen der Raupenprozente entsprechend sind auch die Unterschiede zwischen den korrigierten, rekonstruirten Laubgewichten der einzelnen Jahre gross. Die rekonstruierte Laubproduktion von *Quercus petraea* bewegte sich während der fünf Jahre zwischen 3866 und 6582 kg/ha; die Streuung der Daten war 4814,8 ± 1255,5 kg/ha (CV% = 26,1). Daraus ist ersichtlich, dass der Unterschied zwischen den Werten der einzelnen Jahre wesentlich grösser ist, als im Falle der messbaren Laubgewichte. Wesentlich kleiner sind dagegen die Abweichungen in den rekonstruierten Laubgewichten der anderen Art *(Quercus cerris)* (Tabelle 5).

Die von den laubkonsumierenden Phytophagen jährlich vernichtete Menge war durchschnittlich 1346,1 kg/ha (Tabelle 3). Der Tabelle 5 ist zu entnehmen, dass zwischen den zwei Arten ein wesentlicher Unterschied besteht in Hinsicht auf das Mass des Raupenfrasses, Im Falle von *Quercus petraea* betrug der auf fünf Jahre berechnete durchschnittliche Raupenfrass 24,6 Gewichtsprozent, der eine Laubmenge von 1316,2 kg/ha bedeutet.

Bedeutend kleiner ist das Mass des Raupenfrassen bei der Art *Quercus cerris* (5%), Grosse Unterschiede sind zu beobachten in den Raupenfrassprozenten der verschiedenen Jahre bei *Quercus petraea* (zwischen 7 und 40%), und demnach auch in der konsumierten Laubmenge (zwischen 278,3 und 2803,5 kg/ha).

Streuproduktion der verholzten Komponenten

Wie bereits erwähnt wurde, besteht die Streuproduktion der verholzten Komponenten einerseits aus der Menge der jährlich zugrundegegangenen Bäume, anderseits dagegen aus der Menge der abfallenden toten Zweige. Tabelle 6 stellt die Jahresmenge der verholzten Komponenten der abgestorbenen Bäume dar, die eigentlich der Unterschied zwischen den im Jahre 1972 und 1977 gemessenen toten Phytomassen ist.

Tabelle 6

Phytomass (kg/ha Trockengewicht) und Streuproduktion (kg/ha/Jahr) der verholzten Komponenten von abgestorbenen Quercus petraea-Bäumen

		Äste und Zweige	Stamm	Wurzel	Gesamt
Phytomasse kg/ha	1972	370,1	1031,7	224,3	1626,2
	1977	1091,7	2991,1	653,2	4736,0
Tote Holzmasse, kg/ha/Jahr					
Abgestorbene Bäume		144,3	391,3	85,8	622,0
Abfallende Äste und Zweige		1160,0			1160,0
					1782,0

Anhand unserer Untersuchungen sind im fünfjährigen Zeitraum zwischen 1972 und 1977 insgesamt 26 *Quercus petraea* Exemplare/ha vertrocknet. Während dieser Zeit vertrocknete kein einziges *Quercus cerris*-Exemplar auf der 1 ha grossen Fläche. Dementsprechend vertrockneten jährlich im Mittel 5

Exemplare der Art *Quercus petraea*. Die Phytomasse der jährlich abgestorbenen Bäume (stehende und umgestürzte) beträgt so nach unseren Berechnungen 622 kg/ha Trockensubstanz (Tabelle 6). Im Mittel dreier Jahre (1975—1977) betrug die Menge an jährlich abgefallenen Ästen und Zweigen 1160 kg/ha (Tabelle 6). Durch Ergänzung der Trockensubstanz der zugrundegegangenen *Quercus-petraea*-Exemplare mit diesen Werten ergab sich eine jährliche Produktion an totem Material verholzter Komponenten von 1782 kg/ha (Trockensubstanz). Die Untersuchungen erstreckten sich nicht auf die Produktion der Wurzeln von lebenden Bäumen.

Die Jahresbilanz der Phytomasse

Ein Teil der im Laufe Photosynthese jährlich gebildeten organischen Substanz wird in den verholzten Teilen der lebenden Bäume eine gewisse Zeit lang gespeichert, ein anderer Teil dagegen stirbt jährlich ab und gelangt in Form von Laubstreu Frucht und Blüte auf die Bodenoberfläche. Nach kürzerer oder längerer Zeit gelangt auch ein grosser Teil der in den verholzten Komponenten akkumulierten Stoffmenge auf den Boden. In der Jahresbilanz der Phytomasse wurde deshalb die in die Streu gelangende Menge von der in den verholzten Teilen akkumulierten unterschieden.

Nach unseren Messungen beträgt die Jahresnettoproduktion der gesamten Baumschicht (Laub + verholzte Teile) 10 783,8 kg/ha (Tabelle 3). Diese Jahresproduktion an organischer Substanz macht 1977 4,5% der gesamten lebenden Phytomasse der Bäume aus (vgl. B. PAPP 1974). Anhand obiger Gesamtproduktion beträgt die Nettoproduktivität der Bäume 5,2 g/m²/Tag. Die Länge der Vegetationsperiode kann im Mittel der fünf Jahre mit 207 Tagen angegeben werden (JAKUCS Mskr.). Diese Werte entsprechen bzw. liegen etwas unter den von verschiedenen Autoren (LIETH 1962, 1975; WESTLAKE 1963; OVINGTON 1965; RODIN und BASILEVICH 1968; PRÉCSÉNYI 1971; BISKUPSKY 1975) für laubabwerfende Wälder oder Eichenwälder der gemässigten Zone angegebenen mittleren Werten.

Den grösseren Teil der Gesamtproduktion der Bäume, 53,5%, — auch das Gewicht des Raupenfrasses miteingerechnet — stellt die jährliche Laubproduktion, 43,4% dagegen die jährliche Gewichtszunahme der verholzten Komponenten 3,1% hingegen die Frucht- und Blütenkomponenten dar. Ein grosser Teil (84,2) der messbaren, mit Raupenfrassschaden nicht korrigierten mittleren Laubmenge (4418,9 kg/ha) gelangt in Form von Blattstreu auf die Bodenoberfläche. Nach Messungen von TÓTH, B. PAPP und JAKUCS (Mskr.) betrug nämlich die Laubstreu der Bäume im Mittel von fünf Jahren 3722,8 kg/ha Trockensubstanz. Die Gewichtsabnahme der Blattstreu im Vergleich zu den grünen Blätter — 15,8% (696 kg/ha) — ergibt sich wohl in erster Linie aus einer Substanzrückwanderung aus den Blättern in die verholzten Teile. Ein damit übereinstimmender Prozentwert zur Gewichtsabnahme wird auch

von BRAY und GORHAM (1964) und BURROWS (1972) mitgeteilt. Bei der Gewichtsabnahme spielen selbstverständlich auch noch andere Faktoren eine Rolle wie z. B. die auswaschende Wirkung grösserer Herbstniederschläge (s. SZABÓ, Mskr.) oder der bereits an den Bäumen einsetzende Abbau. Die Ursache der Gewichtsabnahme wurde nicht untersucht.

Wie oben bereits erwähnt, macht die jährliche Gewichtszunahme der verholzten Komponenten beider Arten 4683,9 kg/ha aus (Tabelle 3). Die jährliche Streuproduktion der gleichen Komponenten (abgefallene dürre Äste und Zweige + abgestorbene Bäume) betrug im Mittel 1782 kg/ha, was 38% der Produktion an verholzten Komponenten beider Arten ausmacht. Nach Abzug des toten Materials der verholzten Komponenten liegt die jährlich in diesen gespeicherte Menge an organischer Substanz bei 2902 kg/ha. Aufgrund unserer Untersuchungen kann festgestellt werden, dass die Phytomasse des ungefähr 70jährigen Waldes des Forschungsgebietes noch immer zunimmt, d. h. der Wald befindet sich in der Wachstumsphase.

Nach unseren Berechnungen beläuft sich die in die Streuschicht gelangende Stoffmenge (Laub + abgestorbene verholzte Komponenten + Frucht und Blüte) 5839,6 auf 5839,6 kg/ha. In diesem Wert ist die vermutlich hohe Stoffmenge nicht enthalten, die hauptsächlich mit den Ausscheidungen phytophager Organismen im Laufe des Jahres wieder auf den Waldboden zurückkehrt.

Ein Vergleich der akkumulierten (2902 kg) und in die Streuschicht gelangenden (5839,6 kg) Mengen zeigt, dass mehr als die Hälfte (54%) der organischen Jahresgesamtproduktion in Form abgestorbener Teile jährlich auf die Bodenoberfläche zurückgelangt. Es ist wiederholt zu bemerken, dass in der obigen Stoffbilanz jene Stoffmenge nicht enthalten ist (696,1 kg/ha), die den Unterschied zwischen dem bereits auf dem Baum befindlichen Laubgewicht und der auf den Boden gefallenen Streumenge bedeutet. Diese Stoffmenge wird vermutlich sowohl die in den verholzten Teilen akkumulierte Menge (wegen der Rückwanderung aus den Blättern in die verholzten Teile) als auch die auf die Bodenoberfläche gelangende Menge (Auswaschung im Herbst, an den Bäumen einsetzender Abbau) modifizieren.

LITERATUR

ANTAL, A. (1978): N, P, ill. klorofilltartalom és levélnövekedés vizsgálatok a Quercus petraea leveleken. Diplomamunka. (Untersuchungen von N, P, bzw. des Chlorophylgehalts und Blattwachstums an Quercus-petraea Blättern. Diplomarbeit. Mskr.)

BISKUPSKY, V. (1975): Primary production of the timber component of the biomass in oak-hornbeam forest at BÁB. In: BISKUPSKY, V. (ed.): Research Project BÁB, Progr. Rep II. Bratislava, p. 39—46.

BRAY, J. R.—GORHAM, E. (1964): Litter production in forests of the world. Adv. Ecol. Res., **2**, 101—157.

BURROWS, W. H. (1972): Productivity of an arid zone shrub (Eremophila gilessi) community in south-western Queensland. Aust. J. Bot., **20**, 317—329.

CHAPMAN, S. B. (1976): Production ecology and nutrient budgets. In: Methods in plant ecology (S. B. CHAPMAN ed.). Blackwell Scientific Publications, Oxford—London—Edinburg—Melbourne. p. 157—228.

JAKUCS, P. (1973): »Síkfőkút Project.« Egy tölgyes ökoszisztéma környezetbiológiai kutatása a bioszféraprogram keretén belül. (»Síkfőkút Project.« Environmental-biological research of an oak forest ecosystem within the framework of the biosphere program.) MTA Biol. Oszt. Közl. **14**, 11—25.

JAKUCS, P.—HORVÁTH, E.—KÁRÁSZ, I. (1975): Contributions to the aboveground stand structure of an oak forest ecosystem (Quercetum petraeae-cerris) within the Síkfőkút research area. Acta Biol. Debrecina **12**, 149—153.

JAKUCS, P.—JUHÁSZ, L.: A domináns fajok fenológiai viszonyai. In: JAKUCS, P. (ed.): Studies on the oak forest ecosystem of the Pannonicum. Results of Síkfőkút Project I. (mscr.)

LIETH, H. (1962): Stoffproduktionsdaten. In: LIETH, H. (ed.): Die Stoffproduktion der Pflanzendecke. Fischer, Stuttgart, p. 117—127.

LIETH, H. (1975): Primary production of the major vegetation units of the world. In: LIETH, H.—WHITTAKER, R. H. (eds): Primary productivity of the biosphere. Springer-Verlag, Berlin—Heidelberg—New York. p. 203—215.

NEWBOULD, P. J. (1970): Methods for estimating the primary production of forests. IBP Handbook 2. Blackwell Scientific Publications, Oxford—Edinburgh. pp. 62.

OVINGTON, J. B. (1965): Organic production, turnover and mineral cycling in woodlands. Biol. Rev. **40**, 295—336.

PAPP, L. B. (1974): Aboveground biomass of Quercus petraea and Quercus cerris in the research area at Síkfőkút. Acta Bot. Acad. Sci. Hung. **20**, 333—339.

PAPP, M.—JAKUCS, P. (1976): Phytozönologische Charakterisierung des Quercetum petraeae-cerris-Waldes des Forschungsgebiets »Síkfőkút Project« und seiner Umgebung. Acta Biol. Debrecina **13**, 109—119.

PRÉCSÉNYI, L. (1971): A Föld növénytakarója primér produkciójának becslése. (Schätzung der Primärproduktion der Pflanzendecke der Erde.) Bot. Közl. **58**, 53—57.

RODIN, L. E.—BAZILEVICH, N. I. (1967): Production and mineral cycling in terrestrial vegetation. Oliver and Boyd, Edinburgh. pp. 288.

SOPP, L. (1974): Fatömegszámítási táblázatok. (Tabellen zur Holzmassenberechnung.) Mezőgazdasági Kiadó, Budapest, pp. 408.

SZABÓ, M.: Csapadékvíz vizsgálatok. In: JAKUCS, P. (ed.): Studies on the oak forest ecosystem of the Pannonicum. Results of Síkfőkút Project I. (manuscript).

TÓTH, J.—PAPP, L. B.—JAKUCS, P.: A fásszárúak éves produkciója. In: JAKUCS, P. (ed.): Studies on the oak forest ecosystem of the Pannonicum. Results of Síkfőkút Project I. (manuscript).

VARGA, Z.—LAKATOS, GY.: Lombfogyasztó hernyók szerepe az erdőben. In: JAKUCS, P. (ed.): Studies on the oak forests ecosystem of the Pannonicum. Results of Síkfőkút Project I. (manuscript).

VIRÁGH, K.: Levélnövekedés vizsgálatok. In: JAKUCS, P. (ed.): Studies on the oak forest ecosystem of the Pannonicum. Results of Síkfőkút Project I. (manuscript).

WESTLAKE, D. F. (1963): Comparisons of plant productivity. Biol. Rev. **38**, 385—425.

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ASSOCIATION-ANALYSIS BASED ON THE USE OF MUTUAL INFORMATION

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A new version of association-analysis is presented. The division parameter is defined by means of information theory, the divisive species is that which has the maximum sum of mutual information with all the other species. Application of the method is illustrated by an example. The resulting hierarchy is compared with a previously published one obtained with an agglomerative method and with the result of principal component analysis. Joint application of association-analysis with several different numerical methods is proposed.

I. Introduction

I.1. *Association-analysis* (*AA*) has been one of the most widely used classification methods of plant ecology in the last two decades. The first version of *AA* was the technique of GOODALL (1953) modified by WILLIAMS and LAMBERT (1959, 1960), whose method may be regarded as the most typical monothetic divisive strategy. The set of vegetation samples is subdivided in each cycle of the analysis according to the presence and absence of a single species (key- or divisive species). Main problems of the different *AA* algorithms are the criterion for selection of the divisive species and the definition of a measure for stopping further subdivisions ("stopping rule"). The division parameter of WILLIAMS and LAMBERT was defined by

$$\max \left\{ \sum_{j \neq k} \chi^2_{jk} \right\} \tag{I.1.1.}$$

i.e. the divisive species was that which had the maximum sum of χ^2 values calculated with all the other species. A subset of samples were considered homogeneous and its division was abandoned if the maximum value of χ^2 between any two species was less than a fixed value. Other but similar definitions for division parameter and stopping rule are listed by LANCE and WILLIAMS (1965).

I.2. Since the use of χ^2 has many disadvantages, LANCE and WILLIAMS (1968) modified their procedure on the basis of information theory. Following SHANNON (1948), they defined the "information content" of the set E of m entities (e.g. vegetation samples) described by n binary attributes (e.g. species) as

$$\hat{I}(E) = nm \log m - \sum_i (k_i \log k_i + (m - k_i) \log (m - k_i)) \tag{I.2.1.}$$

where k_i is the number of entities possessing the ith attribute. The set of entities is divided into two subsets E_1 and E_2 according to the presence and absence of each attribute, the reduction of information content ("information fall") is calculated in each case using the relation

$$\Delta\hat{I}(E_1, E_2, E) = \hat{I}(E) - \hat{I}(E_1) - \hat{I}(E_2) \tag{I.2.2.}$$

and that division is performed for which $\Delta\hat{I}$ is maximum. The authors suggested that $2\Delta\hat{I}$ could be used as stopping rule instead of χ^2, but this definition may be strongly criticized (cf. CORMACK 1971).

I.3. More recently numerous authors cast doubt on the ecological reliability of groupings obtained with *AA*. The major criticism is that the resulting hierarchy of vegetation samples is not necessarily an optimal classification because of the monothetic and divisive properties of the algorithm (COETZEE and WERGER 1975). It is easy to see, however, that there is no perfect numerical method which supersede all the others in every respect. Consequently, we do not know a priori that method whose result can be regarded as an "ecologically optimal" classification. Thus absolute disregard of *AA* would be an unwarranted and thoughtless step in spite of its obvious disadvantages. Joint application of *AA* with several different agglomerative methods and ordination procedures seems to be a more reasonable way in vegetation survey.

I.4. In the present paper I give a version of *AA* based on the mutual information measures between attributes. A new definition of division parameter is presented but the question of stopping rule will remain opened. The method, with respect to its result, is probably closely related to that of LANCE and WILLIAMS (1968) and comparison of them requires further investigations.

II. A new version of association-analysis

II.1. As mentioned above the central question of *AA* is the way of selecting the divisive species. If information theoretical definitions are used we obtain a self-explanatory variant of division parameter. In each cycle of the analysis we obviously have to search for that species which contains the highest information about the remaining species. This one is that which has the maximum sum of mutual information values calculated with the others. The mutual information between species s_j and s_k can be calculated using the parameters of the well-known 2×2 contingency table as

$$m\hat{I}(s_j; s_k) = m \log m + a \log a + b \log b + c \log c + d \log d - (a + c) \log (a + c) - (b + d) \log (b + d) - (a + b) \log (a + b) - (c + d) \log (c + d) \qquad \text{(II.1.1.)}$$

where $m = a + b + c + d$ (cf. KULLBACK 1959). Then the division parameter is

$$\max \left\{ \sum_{j \neq k} m\hat{I}(s_j; s_k) \right\} \qquad \text{(II.1.2.)}$$

The set or subset of samples is subdivided according to the selected species. The analysis, with a few exceptions, can be carried out as far as that every cluster contains only one sample. If the maximum sum of mutual information values appears at more than one species we have to examine their distributions. If these are same or symmetric we can regard every species in question as divisive one. Supposing that the distributions are different and asymmetric the subset can not be subdivided further (automatic stopping rule). It is advisable, however, to stop the analysis at an arbitrary group size since the relationships at lower hierarchic levels are usually out of interest.

Since the measure II.1.2. decreases monotonically, reversals are entirely absent from the dendrogram.

II.2. Computer program ASSINF has been written in FORTRAN IV language for the analysis of vegetation samples. The program accepts binary data, prints out the results of each subdivision and gives the dendrogram on the printer. This program is available from the author on request.

III. Application of *AA* and its comparison with other numerical methods

III.1. The new version of *AA* was applied to the study of a rocky grassland community named *Seslerietum sadlerianae* from Hungary. 33 sampling units of 4×4 m size from 7 stands were involved in the analysis

	stand	quadrat No.
I.	Sashegy, Buda Hills	1—5.
II.	Hunyadorom, Buda Hills	6—9.
III.	Tündérszikla, Buda Hills	10—14.
IV.	Hármashatárhegy, Buda Hills	15—18.
V.	Nagykevély, Pilis Hills	19—23.
VI.	Pilistető, Pilis Hills	24—28.
VII.	Naszály Hill	29—33.

Matrix of the presence — absence data and a map illustrating the geographic localization of the stands can be found in a previous publication (Podani, 1978). Dendrogram of the quadrats is shown in Fig. 1.
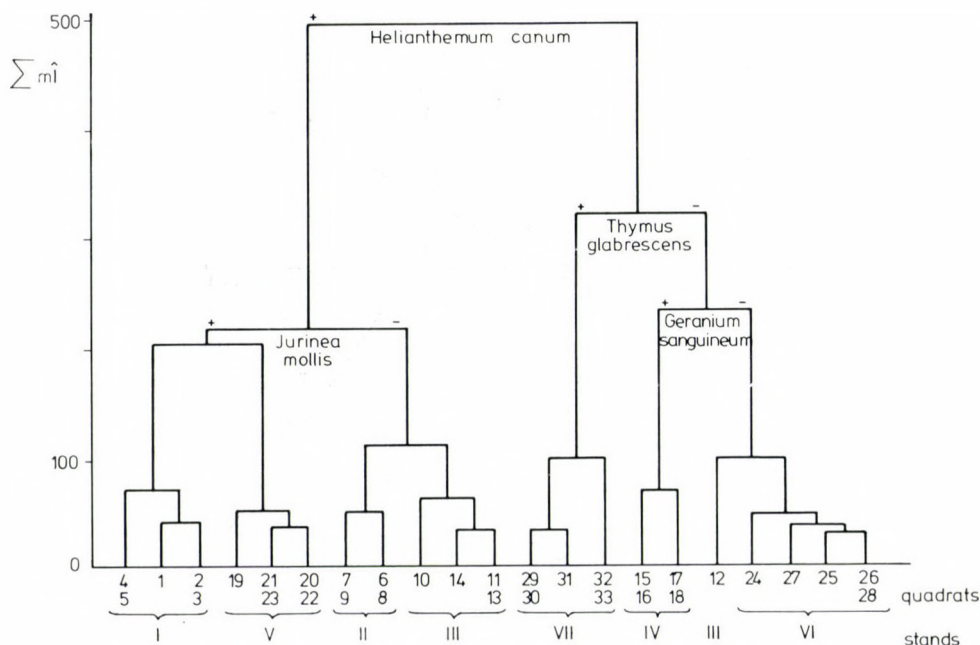
Fig. 1. Hierarchy for quadrats obtained with the new version of association-analysis

The quadrats listed above were formerly subjected to an agglomerative classification (centroid sorting algorithm using the weighted dissimilarity index, see PODANI 1978 for detailed description of the method and for the resulting dendrogram).

PEARSON product-moment correlations between quadrats were also computed. The correlation matrix was analyzed by principal component analysis (see DIXON 1964). For our purposes it is sufficient to examine only the first two components which account for a total of 46% of the variance in the data. The component scores are plotted on the scatter diagram of Fig. 2.

III.2. We can see at a glance on Fig. 1. that the quadrats are clustered according to the stands with the only exception of quadrat 12. First it seems to be a typical case of "misclassification" caused by the absence of Helianthemum canum from quadrat 12 by chance. This quadrat, however, has got close to stands IV and VI in the hierarchy obtained with the centroid sorting method as well so that the possibility of misclassification is surely out of question. This is strengthened by the fact that according to the first two components quadrat 12 is nearest to these stands among the quadrats of the rest.

There are some other remarkable agreements between the results. For example, stands II—III and I—V, respectively, are closely related in every case. Good agreement between *AA* and *PCA* can be illustrated by indicating the first four divisions on the scatter diagram (Fig. 2).

The only essential difference between the classifications appears at the highest hierarchic level. *AA* produced two main groups of almost equal size according to the presence and absence
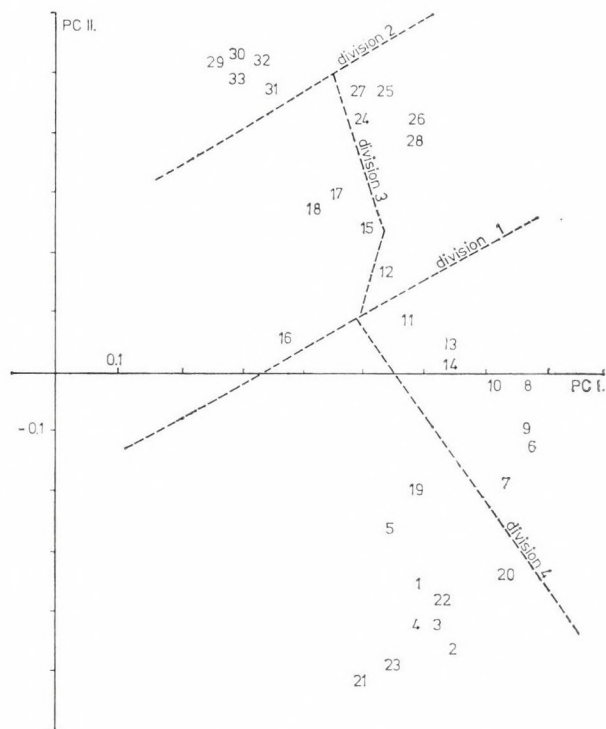
Fig. 2. Principal components ordination of quadrats. Dotted lines indicate the subsequent divisions by association-analysis

of *Helianthemum canum*. In the hierarchy obtained with centroid sorting method stands IV and VI (with quadrat 12) are close to each other as well but they are more similar to the group of stands I, II, III and V than to the stand of Naszály.

III.3. Finally, we can draw the following conclusions from the results:

(i) There are two extreme types within the community studied. These are represented by the stand of Naszály and, on the other hand, by the stands of Sashegy, Hunyadorom, Tündérszikla and Nagykevély. The remaining stands can be considered as transitions between the extreme types.

(ii) According to the classifications and ordination, we have the following order of the stands:

I and V—II—III—IV—VI—VII

(iii) Results can be explained satisfactorily on ecological, floristical and geographical basis. Stand VII is the only one which is grown on limestone, all the others are on dolomite rocks. This stand is nearest to the Northern Range of medium height therefore it contains 17 species which are absent from the other stands. Separation of IV and VI from the rest may be explained by the absence of numerous frequent species (e.g. *Festuca pallens, Seseli leucospermum, Helianthemum canum, Silene otites, Linum tenuifolium, Fumana procumbens, Scorzonera austriaca*, etc.) characterizing the vegetation of dolomite rocks in general.

(iv) Different numerical methods gave rather similar and, for this reason, well-interpretable results. Shortcomings of each method can be reduced by the joint application of them and the comparative evaluation of the results. Cases of misclassification by *AA*, for example, should be treated with caution.

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REFERENCES

Coetzee, B. J.—Werger, M. J. A. (1975): On association-analysis and the classification of plant communities. Vegetatio **30**, 201—206.

Cormack, R. M. (1971): A review of classification. J. Roy. Stat. Soc. series A. **134**, 321—367.

Dixon, W. J. (1964): BMD computer programs manual. University of California at Los Angeles.

Goodall, D. W. (1953): Objective methods for the classification of vegetation I. The use of positive interspecific correlation. Aust. J. Bot. **1**, 39—63.

Kullback, S. (1959): Information Theory and Statistics. Wiley, New York.

LANCE, G. N.—WILLIAMS, W. T. (1965): Computer programs for monothetic classification ("association-analysis"). Computer J. **8,** 246—249.
LANCE, G. N.—WILLIAMS, W. T. (1968): Note on a new information-statistic classificatory program. Computer J. **11,** 195.
PODANI, J. (1978): A method for clustering of binary (floristical) data in vegetation research. Acta Bot. Acad. Sci. Hung. **24,** 121—137.
SHANNON, C. E. (1948): A mathematical theory of communication. Bell System Tech. J. **27,** 379—423, 623—656.
WILLIAMS, W. T.—LAMBERT, J. M. (1959): Multivariate methods in plant ecology I. Association-analysis in plant communities. J. Ecol. **47,** 83—101.
WILLIAMS, W. T.—LAMBERT, J. M. (1960): Multivariate methods in plant ecology II. The use of an electronic digital computer for association-analysis. J. Ecol. **48,** 689—710.

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NICHE STUDIES ON SOME PLANT SPECIES OF A GRASSLAND COMMUNITY. V

THE POSITION OF THE SPECIES IN THE THREE-DIMENSIONAL NICHE SPACE*

By

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The niche width and overlap conditions of nine species of a sandy meadow are dealt with in the study according to the soil moisture content, the root depth, and as a third axis the coverage of the dominant species (*Festuca vaginata*). The niche width is the greatest on the third axis in *Carex stenophylla* and the smallest on that of *Centaurea arenaria*. The average overlap values on this axis are similar; on the basis of this, hardly any separation can be detected. The position of the species niche centrum in the 3-dimensional niche space was also studied by means of the Euclidean distances and cluster analysis. Two species, that is, *Medicago minima* and *Thymus* sp. form a cluster in each of the combinations of the 3 axes; it seems that in resource utilization the two species overlap.

Introduction

The results of the two-dimensional niche investigations of the nine species of the sandy meadow have been presented in three previous studies (FEKETE et al. 1976; PRÉCSÉNYI et al. 1977a, b).

As a third dimension the coverage of the dominant species, *Festuca vaginata*, was taken into consideration. It was supposed that the coverage of the dominant species influences the frequency of the species, and that the frequency of even *Festuca* itself is not identical in each of the percentage values of coverage.

In the present study we first deal with the niche characteristics occurring on the third axis (coverage percentages), then — using the data of the autumn samplings (September 1976), which had already been published previously, — discuss the position of the species in the three-dimensional niche.

Material and Method

The coverage of *Festuca vaginata* was estimated with regard to that occurring in the previously described 100 samples of 50×50 cm² obtained from the sandy meadow of Tece (Vácrátót) in 1976 (VI. 29, VII. 6, and VIII. 31), and the species occurring in the square areas were registered. The estimation of the coverage was carried out with a 5% accuracy (Table 1).

Of the niche characteristics, the LEVINS-type B_i and α_{12} or α_{21} (LEVINS 1968) as well as HORN's index were used (HORN 1966).

* Tece studies № 12.

Table 1

Species frequency related to the coverage percentage of Festuca vaginata

Category coverage, %	I. 0–19	II. 20–39	III. 40–59	IV. 60–79	V. 80–	Total
Festuca	10	46	26	14	4	100
Medicago	7	32	21	13	2	75
Thymus	6	41	22	12	4	85
Euphorbia	4	21	13	7	1	46
Carex	6	29	19	9	4	67
Fumana	5	15	6	3	0	29
Equisetum	1	6	7	6	0	20
Cynodon	3	27	12	6	1	49
Centaurea	1	11	3	1	0	16
Total	43	228	129	71	16	487

Results

Niche width

On this axis the niche width is the greatest in *Carex*, and it is the smallest in *Centaurea* (Table 2, main diagonal). Niche width of *Medicago* is close to that of *Carex*. Also nearly identical is the niche width of *Equisetum* and of *Festuca*.

Table 2

Community matrix

	Festuca	*Medicago*	*Thymus*	*Euphorbia*	*Carex*	*Fumana*	*Equisetum*	*Cynodon*	*Centaurea*
Festuca	3.2216	0.9785	1.0241	1.0127	0.9761	1.0420	0.8892	1.0993	1.2242
Medicago	1.0127	3.3343	1.0356	1.0303	0.9913	1.0425	0.9425	1.1042	1.2087
Thymus	0.9728	0.9504	3.0601	0.9854	0.9495	1.0093	0.8604	1.0764	1.2038
Euphorbia	0.9840	0.9672	1.0079	3.1302	0.9618	0.9275	0.8948	1.0804	1.1951
Carex	1.0188	0.9997	1.0433	1.0332	3.3625	0.8891	0.9209	1.1133	1.2265
Fumana	0.9221	0.8913	0.9403	1.0184	1.0487	2.8508	0.7619	1.0232	1.1735
Equisetum	0.9049	0.9268	0.9219	0.9373	0.8980	0.8762	3.2787	0.7598	0.9631
Cynodon	0.8915	0.8652	0.9190	0.9018	0.8650	0.9377	0.9535	2.6126	1.1337
Centaurea	0.7370	0.7030	0.7629	0.7404	0.7074	0.7983	0.5697	0.8460	1.9394

Niche overlap

The HORN index showed high values in each of the species (Table 3). If we accept the average overlap values as the index of niche separation, than hardly any separation can be stated. The difference between the two extreme values: 0.0505 (Table 4). The autumn root depth and soil moisture content showed much greater differences.

Table 3

Niche overlap values
(HORN *index)*

	Medicago	*Thymus*	*Euphorbia*	*Carex*	*Fumana*	*Equisetum*	*Cynodon*	*Centaurea*
Festuca	0.9970	0.9978	0.9973	0.9977	0.9737	0.9473	0.9912	0.9590
Medicago		0.9941	0.9989	0.9935	0.9684	0.9650	0.9877	0.9479
Thymus			0.9954	0.9972	0.9617	0.9448	0.9938	0.9606
Euphorbia				0.9930	0.9710	0.9565	0.9930	0.9155
Carex					0.9605	0.9412	0.9847	0.9440
Fumana						0.9045	0.9685	0.9695
Equisetum							0.9321	0.8654
Cynodon								0.9784

Table 4

Average overlap values of the species
(HORN *index)*

Species	Average
Festuca	0.9826
Medicago	0.9816
Thymus	0.9807
Euphorbia	0.9826
Carex	0.9765
Fumana	0.9597
Equisetum	0.9321
Cynodon	0.9787
Centaurea	0.9475

Community matrix

On the basis of the community matrix (Tables 2 and 5), the community effect is the highest on *Carex*, and the lowest on *Centaurea*. Therefore, the greatest niche width goes together with the greatest community effect, while the lowest niche width is accompanied by the lowest community effect. *Centaurea* has the highest species effect, while *Equisetum* has the lowest.

Table 5

Community and species effect of the species

	Community effect	Species effect
Festuca	8.2461	7.4438
Medicago	8.3678	7.2821
Thymus	8.0080	7.6550
Euphorbia	8.1106	7.5686
Carex	8.4044	7.2385
Fumana	7.5289	7.7731
Equisetum	7.3835	6.5992
Cynodon	7.2797	8.2963
Centaurea	5.8647	9.3346

The species position in the three-dimensional niche space

The position of the niche centres of the species in the two- and three-dimensional space is shown in Figs 1 and 2. Since the measurements of the three characteristics were taken at different times, D^2-analysis could not be applied to the determination of the distances of the species from one another in the three-dimensional space. The following method was chosen for its estimation: the mean values of the species was calculated in relation to each of the characteristics (the estimation of the niche centres), these mean values were standardized, then from the standardized data the Euclidean distances occurring between them were calculated (Table 6). *Fumana* stands the farthest from

Table 6

Euclidean distance between niche centres of the species on the basis of three niche characteristics (standardized values)

	Medicago	*Thymus*	*Euphorbia*	*Carex*	*Fumana*	*Equisetum*	*Cynodon*	*Centaurea*
Festuca	0.527	0.666	2.470	1.391	3.900	2.936	3.061	2.673
Medicago		0.173	2.374	0.993	3.987	2.735	2.998	2.778
Thymus			2.351	0.891	3.973	2.749	2.967	2.322
Euphorbia				1.684	2.023	1.183	0.683	1.588
Carex					3.485	1.898	2.298	2.423
Fumana						3.466	1.457	1.431
Equisetum							2.133	3.221
Cynodon								1.465
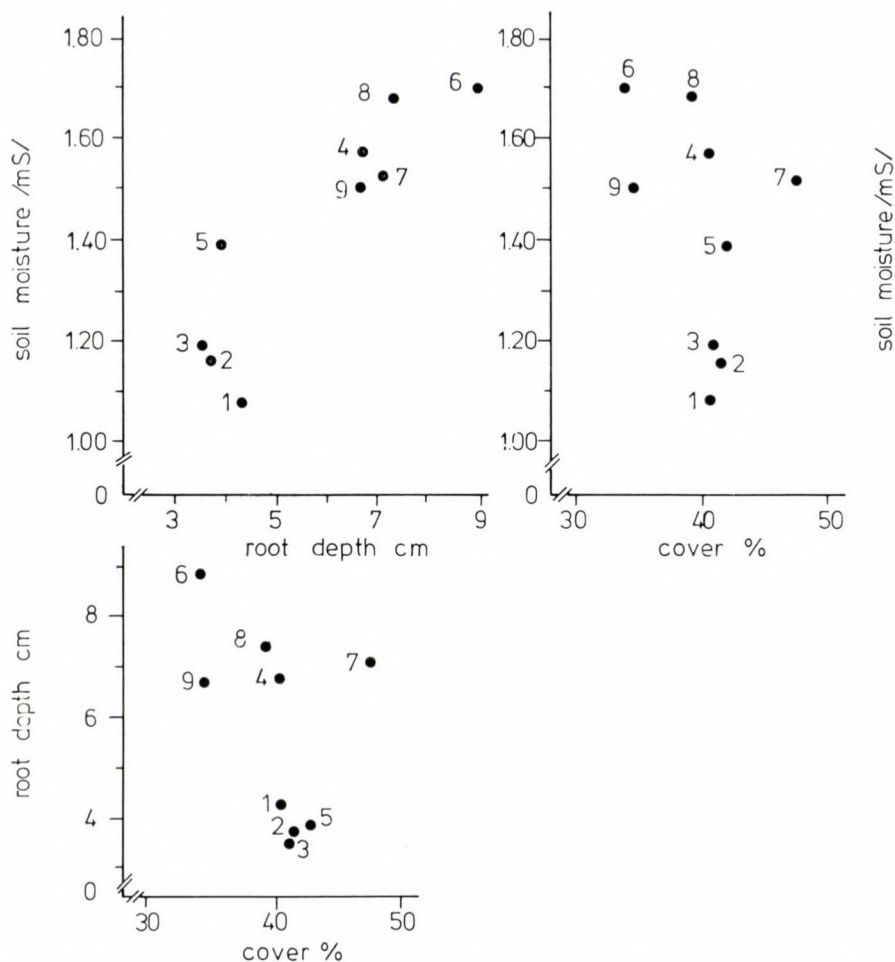
Fig. 1. The position of the niche centres of the species in the two-dimensional niche space. The numbers in Fig. 1. and 2. refer to the orde r of species i n Tables.

the *Medicago* and in general it separates from most of the species. The distance is the smallest between *Medicago* and *Thymus. Festuca, Medicago* and *Thymus* are very near to one another.

On the basis of the distances, cluster analysis was carried out using the method of SOKAL and MICHENER (1958). The nearness of the three species mentioned above is indicated by the fact that they form a common cluster (Fig. 3). The *Euphorbia-Cynodon* pair also forms one cluster. Four of the nine species (*Festuca, Medicago, Thymus* and *Carex*) form a group well-separating from the rest of the species. *Equisetum* differs from the four other species; it joins the *Euphorbia-Cynodon* and the *Fumana-Centaurea* groups with very low values.
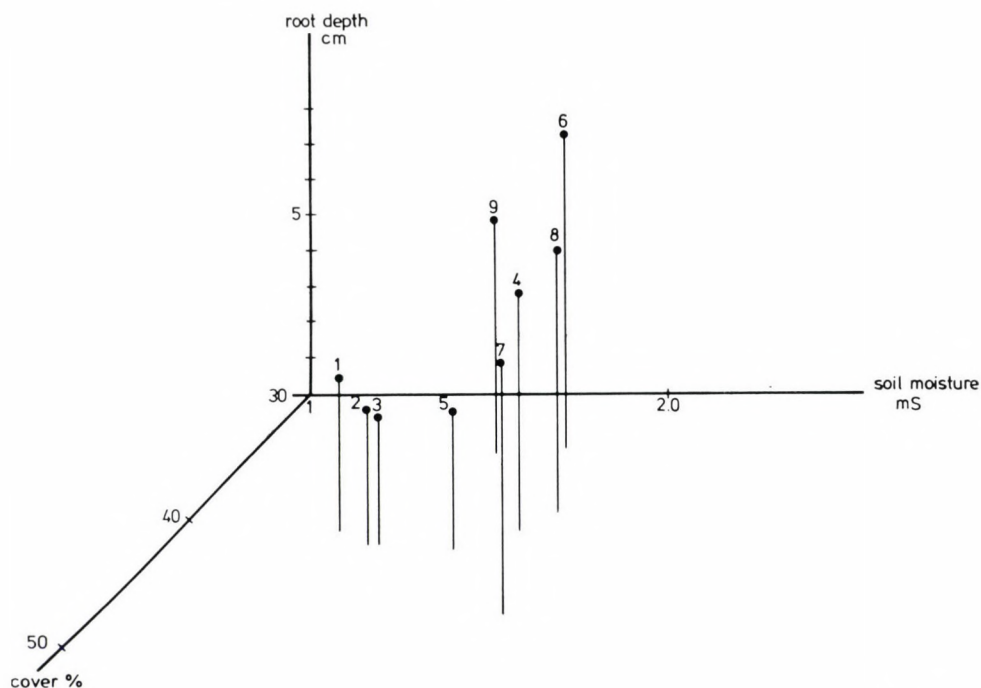
Fig. 2. The position of the niche centres of the species in the three-dimensional niche space
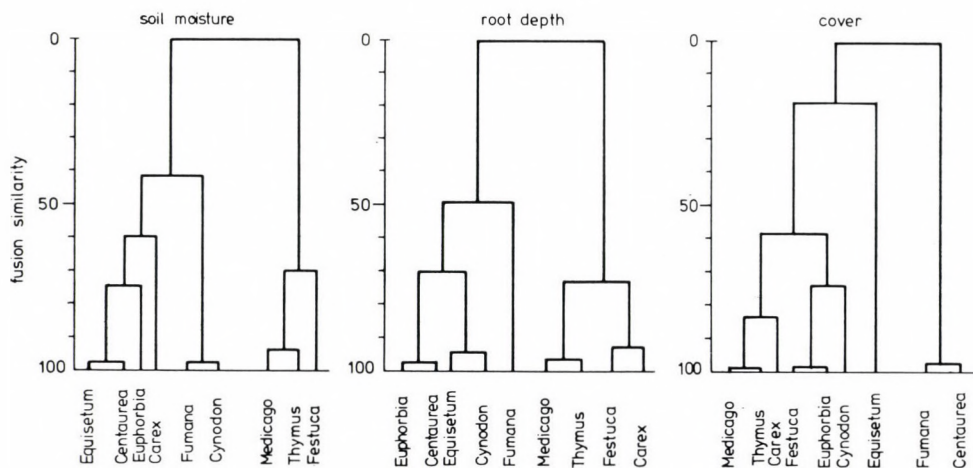
Fig. 3. Dendrograms of the species studied in one-dimensional niche space

The species pair *Medicago-Thymus* is interesting: it forms a cluster in each of the combinations of the three niche axes (Fig. 4). These species — according to even the dendrograms given in our preceeding study — are to be found always in pairs, with high similarity values, in the autumn examination,
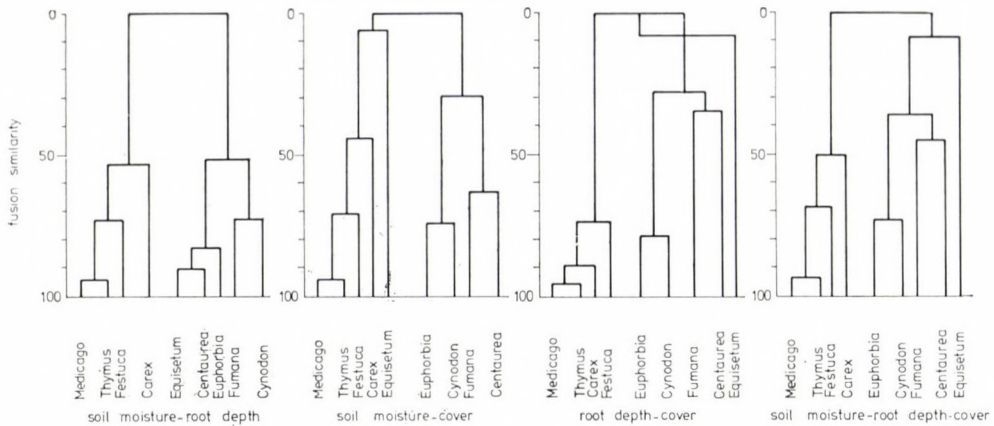
Fig. 4. Dendrograms of the species studied in two- and three-dimensional niche spaces

although to the dendrograms we did not apply the niche centres, nor even the Euclidean distances (Précsényi et al. 1977b). To this species pair joins either *Festuca*, or *Carex*, or both. The state of *Medicago* and *Thymus* niche centres being located side by side may be an indication that they use the same resources. This supposition seems to be supported also by the fact that the product of the values of species and community effect is close to 1 in the two species (Tables 7 and 8); Christiansen and Fenchel (1977) explains this in terms of their resource utilization that the two species overlap. The statement of Christiansen and Fenchel that the value denoted α by them can be

Table 7

"α"-values of the species (Christiansen and Fenchel, 1977)

	Festuca	*Medicago*	*Thymus*	*Euphorbia*	*Carex*	*Fumana*	*Equisetum*	*Cynodon*	*Centaurea*
Festuca		0.857	0.800	0.320	0.558	0.178	0.280	0.206	0.357
Medicago	0.755		0.990	0.377	0.725	0.163	0.215	0.210	0.303
Thymus	0.713	0.994		0.381	0.734	0.179	0.216	0.220	0.275
Euphorbia	0.375	0.058	0.032		0.851	0.829	0.839	0.929	0.890
Carex	0.947	0.918	0.890	0.201		0.551	0.598	0.652	0.525
Fumana	0.034	0.007	0.003	0.385	0.015		0.945	0.966	0.707
Equisetum	0.321	0.153	0.121	0.750	0.230	0.689		0.914	0.762
Cynodon	0.059	0.033	0.014	0.406	0.044	0.349	0.481		0.830
Centaurea	0.228	0.177	0.135	0.535	0.198	0.405	0.790	0.772	

Soil moisture content in the top right-hand semi-matrix;
Root depth in the botton left-hand semi-matrix.

Table 8

"α"-values of the species (Christiansen and Fenchel, 1977) *coverage %*

	Medicago	*Thymus*	*Euphorbia*	*Carex*	*Fumana*	*Equisetum*	*Cynodon*	*Centaurea*
Festuca	0.991	0.995	0.996	0.994	0.961	0.805	0.980	0.902
Medicago		0.984	0.996	0.991	0.929	0.873	0.955	0.850
Thymus			0.993	0.991	0.949	0.793	0.989	0.918
Euphorbia				0.994	0.945	0.839	0.974	0.885
Carex					0.932	0.827	0.963	0.868
Fumana						0.668	0.959	0.937
Equisetum							0.724	0.549
Cynodon								0.964

higher than 1 has so far not been experienced by us, and it even cannot be possible according to our considerations if we estimate the values by means of Levins' formula (1968).

REFERENCES

Christiansen, F. B.—Fenchel, T. M. (1977): Theories of populations in biological communities. Springer, Berlin—Heidelberg—New York, 144 pp.

Fekete, G.—Précsényi, I.—Molnár, B.—Melkó, E. (1976): Niche studies on some plant species of a grassland community. I. Comparison of various measurements. Acta Bot. Acad. Sci. Hung., **22**, 321—354.

Horn, H. S. (1966): Measurement of "overlap" in comparative ecological studies. Amer. Naturalist, **100**, 419—424.

Levins, R. (1968): Evolution in changing environment. Princeton, New Yersey, 120 pp.

Précsényi, I.—Fekete, G.—Melkó, E.—Molnár, E. (1977a): Niche studies on some plant species of a grassland community. II. Seasonal niche dynamic. Acta Bot. Acad. Sci. Hung., **23**, 193—218.

Précsényi, I.—Fekete, G.—Melkó, E.—Molnár, E. (1977b): Niche studies on some plant species of a grassland community. III. Overlap investigations by cluster analysis. Acta Bot. Acad. Sci. Hung., **23**, 367—374.

Sokal, R. R.—Michener, C. D. (1958): A statistical method for evaluating systematic relationships. Univ. Kansas Sci. Bull., **38**, 1409—1438.

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MANNIA TRIANDRA (SCOP.) GROLLE IN HUNGARY

By

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(Received September 20, 1978)

Mannia triandra (Scop.) Grolle, an alpine-montane element new to Hungarian bryoflora was discovered in the Bükk Mountains (NE Hungary), which, according to its distribution pattern and to its habitat, seems to be a glacial relic here, at 600 m altitude.

From 5—8 June, 1978, a Workshop Meeting was held for the bryologists of socialist countries. During one of the study trips of this meeting, on 7 June the author discovered an interesting liverwort species new for the Hungarian bryoflora: *Mannia triandra* (Scop.) Grolle, in the Bükk Mountains, on the E faced dolomite cliffs of Vöröskő-Hill near Ómassa village, at 600 m altitude above sea level. Drs. R. GROLLE and J. VÁŇA, participants of the same trip, identified the plant tentatively already in the field and the further studies confirmed their statement. The author expresses her gratitude towards them for the identification.

Basionymon:

Marchantia triandra Scop., Fl. Carniol., Aufl. 2, 2: 354, No. 1356, tab. 63 (1772).

Synonyms:

Grimaldia triandra (Scop.) Lindenb. in Kerner, Sched. Fl. Exs. Austro-Hung. 3: 159 (1884).
Duvalia rupestris Nees, Ges. Naturf. Freunde Berlin 8: 271 (1817).
Grimaldia rupestris (Nees) Lindenb., Nova Acta Leop. 14, Suppl.: 108 (1829).
Neesiella rupestris (Nees) Schiffn. in Engler and Prantl, Natürl. Pflanzenfam., Aufl. 1: 33 (1893).
Mannia rupestris (Nees) Frye and Clark, Univ. Wash. Publs. Biol. 6: 67 (1937).

Description of the species:

Autoicous, relatively small plant. Thallus short, heart shaped, with repeatedly divided segments and with ventral branches. Colour of thallus pruinose bluish green, the surface is divided into relatively large areolae according to the air chambers beneath. The epidermis is thin and often lacking, dehiscing above the chambers. Air chambers in several layers, without filaments of photosynthetic cells. Pores surrounded by 8—9 thin walled cells in 1—2 rings. Assimilating pigments into about half depth of the thallus. Ventral scales small, triangular, hyaline or pale purple, with lanceolate appendages at their apex, slime papillae at their margin and with pale brown oil cells. Antheridia in small discs at the ends of thallus segments. Archegonia covered by few, long scales at the two ends. Carpocephalum hemisphaeric, surface rough, with barrelshaped pori. Spores brown, 60—70 μm in diameter, without well defined areolation. Elaters yellowish brown, 8 μm wide, with 2—3 spirals. Chromosome number: 8. (See Fig. 1.)

The above species is easily distinguishable from *Mannia fragrans* (Balbis) Frye et Clark, which is quite common in Hungary. *Mannia fragrans* has dark green thalli, when fresh, with finely papillose surface. Its air chambers are filled with assimilating filaments, the epidermis cell walls are thickened with distinct trigones, the ventral scales are much larger than those of *M. rupestris*, halfmoon shaped and dark purple violet in colour. The thallus of *M. fragrans* is usually with a scent of cedar-oil, while *M. rupestris* is odourless.
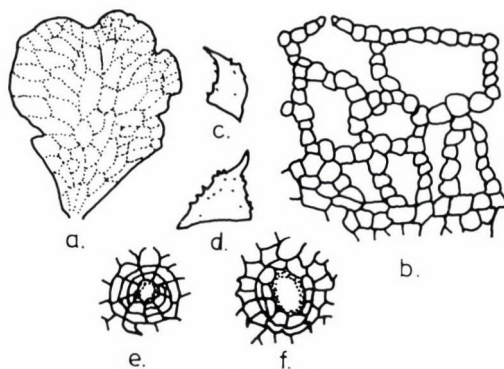
Fig. 1. Mannia triandra (Scop.) Grolle (after K. MÜLLER 1952) — a: Dorsal view of thallus — b: Transversal section of assimilating tissue with the air chambers — c: and d: Ventral scales — e and f: Dorsal view of pori

Their ecological requirements and habitats are also different. *Mannia fragrans* is a typical xerophyte living on the open humus ground of slope steppes, among the *Festuca* tussocks.

On the other hand, the Hungarian habitat of *Mannia triandra* is a shady, mesophilous forest on steep dolomitic rocks, with such, in Hungary rare and, as glacial relic species treated plants in its undergrowth, as *Cirsium erisithales*, *Atragene alpina*, *Rubus saxatilis* and *Calamagrostis varia* (dominant species). All these plants are more common only in the spruce region of the Carpathians in Slovakia. *Mannia triandra* fits well in this relic community and *should be treated in Hungary, as an altimontane species with glacial relic character.*

Distribution

Mannia triandra has in Europe an alpine distribution pattern. It does not occur in Scandinavia, but known from Japan and also from the United States and Canada.

In Central Europe it is scattered in the Alps (first of all in its limestone ranges), it occurs at medium altitudes in France, Bohemia and in Germany, it lives in the Northern, Eastern and Southern Carpathians and in several places of the Balcan Peninsula (see Fig. 2).

Its usual habitats are the crevices of limestone or other calciferous rocks of relatively high altitudes (up to 2600 m in Steyermark). Most of the localities lie in the spruce forest or in the subalpine zone. According to the literature, it seems to prefer the slightly basic soils. The thallus disintegrates after ripening the spores according to GAMS. Our specimens were all sterile.

Europe

FRANCE: Massif Central, Auvergne, Roffiac; SWITZERLAND: Bern, Tessin, Wallis Alps; WEST and EAST GERMANY: Muggendorf (typus), Pottenstein, Kehlheim, Echstätt, Nebelhorn, München and other places in the Alps; Thüringer Wald; AUSTRIA: in all provinces; POLAND: Krkonose Mts.; CZECHOSLOVAKIA: Krkonose Mts., Hruby Jesenik, Velká Fátra, Nizké Tatry, Slovensky raj, Liptovské Hole, Mala Fatra Mts. between 600 and 1666 m altitudes; SOVIET UNION: Hoverla Mts. in Carpathian Ukrainie; ROMANIA: Bucegi, Cibinului and Fagaraş Mts. in the Southern Carpathians; YUGOSLAVIA: Dalmatia, Hrvatska, Slovenia, Bosna, Črnagora; BULGARIA: Southern Pirin Mts.; ITALY: Alps.

Fig. 2. European distribution of *Mannia triandra* (Scop.) Grolle (original)

North America

CANADA: Quebec and Ontario; USA: Eastern part to the Mississippi.

Asia

JAPAN: Hokkaido near Sapporo (at 250 m altitude!).

REFERENCES

Duda, I.—Váňa, J. (1974): 10. Mannia rupestris (Lindenb.) Frye et Clark in Die Verbreitung der Lebermoose in der Tschechoslowakei XV. Čas. Slez. Muz. Ser. A, XXIII, 19—21.
Grolle, R. (1975): Miscellanea hepaticologica 141—150. Journ. Bryol. **8**, 483—492.
Grolle, R. (1976): Verzeichnis der Lebermoose Europas und benachbarter Gebiete. Feddes Rep. **87**, 171—279.
Müller, K. (1951—1958): Die Lebermoose Europas. Rabenh. Krypt. Fl. Deutschl. Ed. 3, 6. Leipzig, 1365 pp.
Papp, C. (1967): Briofitele din Republica Socialista Romania. 10. pp.
Pavletić, Z. (1955): Prodromus Flore Briofita Jugoslavije. Zagreb, 578 pp.
Pavletić, Z. (1968): Flora Mahovina Jugoslavije. Zagreb, 103 pp.
Petrov, S. (1975): Bryophyta Bulgarica clavis diagnostica. Sofia, 536 pp.
Szafran, B. (1966): Wantrobowce. (Hepaticae), Tom. I. Warszawa, 89 pp.

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WACHSTUMSANALYSE DER SONNEN- UND SCHATTENBLÄTTER VON QUERCUS CERRIS UND QUERCUS PETRAEA (1973—1975)*

Von

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Vorliegende Mitteilung hat die Blattflächen- und Trockengewichtszunahme der Sonnen- und Schattenblätter zweier Eichenarten, *Quercus cerris* und *Quercus petraea* zum Gegenstand. Die Wachstumscharakteristika RGR, NAR, LAR und RLGR wurden berechnet, um die photosynthetische Produktionsdynamik verfolgen zu können. Die gewonnenen Ergebnisse geben Aufschluß über die zeitliche Veränderung der Fläche, die Akkumulierung organischer Substanz und die Veränderung der Wachstumscharakteristika von Blättern der einzelnen Arten, die aus Schichten mit unterschiedlichem Lichtgenuß stammen. Es wurde untersucht, wie ausgeprägt Ähnlichkeit und Abweichung zwischen Licht- und Schattenblättern im Hinblick auf die Wachstumsvorgänge einerseits und zwischen den beiden Eichenarten andererseits sind. Die Wachstumsanalysen wurden 1973, 1974 und 1975 durchgeführt. Blattfäche und -gewicht wurden als faktorieller Versuch ausgewertet.

Es wurde festgestellt, daß die Fläche von Sonnenblättern stets viel kleiner ist als die von Schattenblättern. Trotz der geringeren Fläche ist jedoch deren Gewicht immer höher. Die Produktion von organischer Substanz verläuft in den Sonnenblättern mit größerer Intensität und Geschwindigkeit sowie höherer Wirksamkeit. In diesen ist im Vergleich zu Schattenblättern der Wert für RGR höher. Das bezieht sich auch auf die Netto-Assimilationsrate.

Die Blätter beider Arten zeigen in den Wachstumsvorgängen sehr viele gemeinsame Züge. Die zeitliche Veränderung der Wachstumscharakteristika ist in den drei Untersuchungsjahren ähnlich. RGR und NAR zeigen einen einer negativen Exponentialkurve entsprechenden Verlauf. Im Hinblick auf die Intensität der Gewichtszunahme bestehen kaum Unterschiede zwischen beiden Arten. Ähnlichkeit weisen die Werte für RGR und NAR auf. Bei *Quercus cerris* verläuft die Gewichtszunahme allerdings in Sonnenblättern schneller und die Werte für RGR und NAR sind höher als bei *Quercus petraea*. Der Energiegehalt der Sonnenblätter von *Quercus cerris* ist stets höher als der von *Quercus petraea* (PAPP, L. B., PAPP, M. und TÓTH 1976).

Einleitung

Ein zur Schätzung der Produktion von Pflanzen und Pflanzengesellschaften anwendbares Näherungsverfahren ist die Wachstumsanalyse, mit deren Hilfe die Dynamik der photosynthetischen Produktion verfolgt werden kann. Diese Methode wurde von englischen Ökologen (BLACKMAN, V. H. 1919, BRIGGS, KIDD und WEST 1920, GREGORY 1917, FISCHER 1920, WILLIAMS 1946, WATSON 1952, 1958, 1959, COOMBE 1960, WHITEHEAD 1962, VERNON und ALLISON 1963, HUGHES 1967, BLACKMAN, G. E. 1968) ausgearbeitet.

* Síkfőkút-Project Nr. 48.

Das wichtigste Charakteristikum des Wachstums ist die relative Wachstumsrate (relative growth rate = RGR; BLACKMAN, V. H. 1919, BRIGGS, KIDD und WEST 1920). Diese ist ein Ausdruck für das zeitliche Akkumulierungsverhältnis von organischer Primärsubstanz, für die Wachstumsgeschwindigkeit. Wird nicht mit Gewichten, sondern Blattflächen gerechnet, so erhält man die relative Blattflächen-Wachstumsgeschwindigkeit (relative leaf growth rate = RLGR) für einen bestimmten Zeitraum.

Die RGR kann zu einem gegebenen Zeitpunkt in das Produkt eines physiologischen und eines morphologischen Charakteristikums gegliedert werden (RADFORD 1967, EVANS 1972, BRIGGS, KIDD und WEST 1920).

Die physiologische Komponente ist die Netto-Assimilationsrate (net assimilation rate = NAR; BRIGGS, KIDD und WEST 1920, GREGORY 1926, EVANS 1972), die die Tageseffizienz der Nettophotosyntheseproduktion des assimilierenden Systems auf eine Assimilationsflächeneinheit bezogen beschreibt. Die NAR ist ein sehr brauchbarer Ausdruck für die Differenz zwischen täglicher Photosyntheserate und täglicher Respirationsrate der ganzen Pflanze. Mittelbar drückt diese auch das Photosynthesevermögen der Blätter aus.

Die andere RGR bestimmende Komponente ist das Blattflächenverhältnis (leaf area ratio = LAR). Dieses morphologische Charakteristikum wird als Quotient von Assimilationsfläche und Gewicht der Pflanze gedeutet (BRIGGS, KIDD und WEST 1920, BLACKMAN, G. E. 1968). Im folgenden werden die allgemein gebräuchlichen Abkürzungen der englischen Bezeichnungen verwendet.

Wachstumsanalyse wurde bisher hauptsächlich an ein- oder mehrjährigen Gräsern (BLACKMAN, V. H. 1919, BRIGGS, KIDD und WEST 1920, WILLIAMS 1946, BLACKMAN, G. E. und WILSON 1951, WATSON 1952, BLACKMAN, G. E. und KEMP 1955, COOMBE 1960, EVANS und HUGHES 1960, HUNT und COOPER 1967, BLACKMAN, G. E. 1968, EGED, KOLEK und DUDA 1970, EVANS 1972) bzw. mit Propfung oder Schnitt gezogenen Sämlingen (COOMBE 1960, MAGGS 1960, REES 1963, JARVIS, P. G. und JARVIS, S. M. 1964, ANDO 1965, HUXLEY 1967, FARMER 1975) durchgeführt. Für Bäume bzw. Blätter von Bäumen wurde die Wachstumsanalyse bisher kaum angewandt.

Drei Jahre hindurch erfolgte an Blättern bzw. Trieben zweier Eichenarten, *Quercus petraea* und *Quercus cerris* Wachstumsanalyse. Die Erfahrungen dieser drei Jahre zeigten, daß auch im Falle von Bäumen bei Blättern und einjährigen Trieben die »klassische« Wachstumsanalyse mit ausreichender Zuverlässigkeit verwendet werden kann.

Ziel der Untersuchungen war es, Informationen über die Akkumulierung von organischer Substanz in den Blättern zweier Baumarten, über die Assimiliationstätigkeit der Blätter und die Dynamik der Photosyntheseproduktion in Laubkronenschichten mit unterschiedlichem Lichtgenuß zu erhalten. Die Messungen erfolgten daher parallel an Sonnen- und Schattenblättern. Aus den Flächen- und Gewichtsdaten wurden die Wachstumscharakteristika (RGR, NAR, LAR, RLGR) berechnet.

Die Untersuchungen wurden im Rahmen des Ökosystem-Forschungsprogramms der MAB (JAKUCS 1973, JAKUCS und VIRÁGH 1975) vorgenommen. Die untersuchte Waldgesellschaft (Síkfőkút-Project) ist ein ungefähr 60—65jähriges in der Hügellandschaft zwischen der Ungarischen Tiefebene und dem Nördlichen Ungarischen Mittelgebirge in der Nähe von Eger auf einem 300 m ü. M. ausgedehnten Hügel gelegenes *Quercetum petraeae-cerris. Quercus petraea* und *Quercus cerris*, die Laubkronenschicht bildenden Baumarten haben einen Deckungsanteil von 84 bzw. 16%.

Probenentnahme

1. Für beide Arten wurden je drei Probebäume möglichst gleicher Entwicklung von ähnlichem Habitus und ähnlicher Phänologie aus ähnlicher Umwelt ausgewählt. Die Bäume wiesen im Hinblick auf Blattflächen- und -gewichtsverhältnisse natürlich individuelle Variabilität auf.

Die Varianz mittlerer Flächen- und Gewichtsdaten der von einzelnen Bäumen stammenden Blätter unterschied sich aber in keinem Jahr, bei keiner Eichenart und auch nicht in der Relation Sonnen- und Schattenblätter. Anhand von Blattfläche und -gewicht konnte die Ausgeglichenheit der drei Bäume als gleich betrachtet werden.

2. Blattwachstum und Photosynthesevermögen stehen mit dem von der Struktur der Laubkronenschicht abhängigen Lichteinfall, der diffusen und direkten Lichtmenge sowie deren Verhältnis zueinander in Zusammenhang. Aus diesem Grund wurden bei jeder Probenentnahme von oberen äußeren (Sonnentrieb, Sonnenblatt; Höhe von ca. 16 m) und unteren inneren stammnahen (Schattentrieb, Schattenblatt; Höhe von ca. 6 m) Bereichen Proben ent-

nommen. Bei jeder Probenentnahme wurden je 10 der entwickeltsten, bei Sonnentrieben der entwickelten Spitzentriebe entnommen.

3. Das Einsammeln des Untersuchungsmaterials erfolgte stets triebweise. Diese Proben-, entnahmemethode wurde auch dann für richtiger gehalten, wenn die mittleren Blattmaße festgestellt werden sollten bzw. die Wachstumscharakteristika für Blätter berechnet wurden. So war es möglich, Fläche und Gewicht der an den Trieben befindlichen Blätter unterschiedlichen Alters und Entwicklung weniger subjektiv zu berücksichtigen.

4. Proben wurden während der Phase raschen Wachstums im Frühjahr ein- bzw. zweiwöchentlich, später, als das Flächenwachstum der Blätter bereits als beendet betrachtet werden konnte (Ende Juni) im allgemeinen monatlich entnommen (Tabelle 1).

Tabelle 1

Zeitpunkte der Probenentnahmen

1973	1974	1975
18. April	27. April	23. April
4. Mai	3. Mai	2. Mai
10. Mai	10. Mai	
24. Mai	16. Mai	14. Mai
13. Juni	19. Juni	4. Juni
27. Juni	26. Juni	29. Juni
27. Juli	25. Juli	20. Juli
23. Aug.	29. Aug.	29. Aug.
16. Sept.	25. Sept.	24. Sept.

Material und Methode

1. Die Blattflächenbestimmung erfolgte mit dem Lichtplanimeter (Czellár und Papp L. B. 1975). In den Messungen bzw. Berechnungen beziehen sich die Flächenwerte einheitlich auf die eine Seite der Blattspreite (Carlisle, Brown und White 1966).

2. In allen drei Untersuchungsjahren trat eine starke Raupengradation auf, die die Blätter in bedeutendem Maße schädigte. Die Rekonstruierung der ursprünglich unbeschädigten Blattfläche erfolgte durch Regressionsanalyse. Die einzelnen Eichenarten und deren aus Sonnen- und Schattenschichten stammende Blätter wurden getrennt behandelt. Die Regressionsanalyse erfolgte an einzelnen Probenentnahmen. Nur dann wurden aufeinander folgende Zeitpunkte zusammengezogen, wenn wegen Raupenschaden sehr wenig ganze Blätter zur Verfügung standen oder die Flächenzunahme der Blätter als beendet betrachtet werden konnte. Getrennt wurden auch die Zusammenhänge zwischen den charakteristischen Maßen von neuen, jungen Blättern untersucht, die sich nach dem Raupenfraß entwickelten und auch morphologisch von den »alten« Blättern abwichen.

Die Berechnungen wurden unter Verwendung der linearen Funktionen von Länge-Fläche, Breite-Fläche bzw. dem Produkt Länge $\times$ Breite-Fläche (Carlisle, Brown und White 1966, Kubiček 1971, Květ-Marshall 1971) durchgeführt.

3. Die nach Bäumen und Schicht getrennten Blätter wurden 48 Stunden lang bei 85 °C getrocknet und anschließend gewogen.

4. Die mit Hilfe von Regressionsgleichungen errechneten, den unbeschädigten Blattflächen entsprechenden Gewichte der durch Raupenfraß beeinflußten Blätter wurde anhand der auf 1 cm^2 Blattfläche entfallenden Gewichte angegeben.

5. In den Untersuchungen stellen mittlere Blattfläche und -gewicht das Mittel aller unbeschädigten und rekonstruierten beschädigten Blätter an je 30 Sonnen- und Schattentrieben, die zur Probenentnahme von 3 Bäumen gesammelt wurden, dar.

6. Die untersuchten Wachstumscharakteristika wurden aufgrund der in Tabelle 2 mitgeteilten Formeln berechnet.

Tabelle 2

Mathematische Definitionen und Einheiten der Wachstumscharakteristika

Relative Growth Rate relative Wachstumsrate	$\overline{\text{RGR}}$	$\frac{l}{W}\frac{dW}{dt} = \frac{ln\,W_2 - ln\,W_1}{t_2 - t_2}$	g/g/Tag
Net Assimilation Rate Netto-Assimilationsrate	$\overline{\text{NAR}}$	$\frac{l}{A}\frac{dW}{dt} = \frac{W_2 - W_1 \ln A_2 - \ln A_1}{t_2 - t_1\, A_2 - A_1}$	$g/cm^2/Tag$
Leaf Area Ratio Blattflächenverhältnis	$\overline{\text{LAR}}$	$\frac{A}{W} = \frac{A_1 + A_2}{W_1 + W_2}$	cm^2/g
Relative Leaf Growth Rate relative Blattflächen-Wachstumsgeschwindigkeit	$\overline{\text{RLGR}_A}$	$\frac{l}{A}\frac{dA}{dt} = \frac{\ln A_2 - \ln A_1}{t_2 - t_1}$	$cm^2/cm^2/Tag$

Ergebnisse und Diskussion

Quercus cerris L.

Flächen- und Gewichtsveränderungen

Die zeitliche Veränderung von Gewicht und Fläche der »Durchschnittsblätter« von *Quercus cerris* wird in Tabelle 3 vorgestellt.

Die Flächenzunahme verläuft im Frühjahr besonders rasch. Sowohl die Sonnen- als auch die Schattenblätter erreichen bereits Mitte Juni ihre volle Entwicklung. Danach ändert
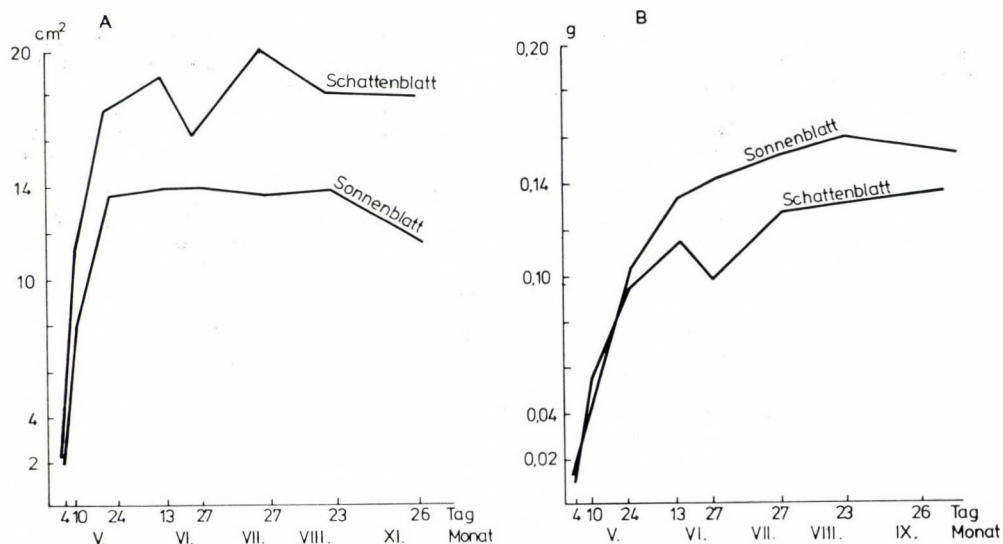
Abb. 1. Zeitliche Veränderung von Fläche (A) und Gewicht (B) »mittlerer unbeschädigter« Blätter von *Quercus cerris* — 1973

sich die mittlere Blattgröße im Laufe der Vegetationsperiode nicht mehr wesentlich. Der Prozeß der Gewichtszunahme ist demgegenüber gemäßigter und abgestufter. In beiden Lichtversorgungsschichten erreichte das Blattgewicht erst gegen Ende Juli—August seinen maximalen Wert (Abb. 1).

Die zeitliche Veränderung der Mittelwerte von Blattflächen und -gewichten ist aber nicht kontinuierlich, sondern wird von starken Abfällen und Schwankungen charakterisiert (Tabelle 3). Die Ursache dafür ist, daß die Wachstumsprozesse wegen des schädigenden Raupenfraßes nicht ungestört verlaufen konnten. Der Höhepunkt der Raupengradation zeigte sich im Mai, Anfang Juni und eventuell Ende August. Konnten die neuen Blätter von den bereits entwickelten getrennt werden und wurden diese bei der Berechnung der durchschnittlichen Blattfläche (-gewicht) nicht berücksichtigt, dann veränderte sich die mittlere Größe der Blätter ab Ende Juni nicht mehr (Abb. 2).

Tabelle 3

Zeitliche Veränderung von Fläche und Gewicht mittlerer unbeschädigter Blätter von Quercus cerris

Zeitpunkte	Fläche (cm²)		Gewicht (g)	
	Sonnenblatt	Schattenblatt	Sonnenblatt	Schattenblatt
1973				
4. Mai	2,45	2,45	0,0174	0,0174
10. Mai	7,94	11,21	0,0432	0,0540
24. Mai	13,55	17,35	0,1004	0,0941
13. Juni	13,91	18,76	0,1342	0,1147
27. Juni	13,93	16,29	0,1422	0,0989
27. Juli	13,52	19,82	0,1526	0,1082
23. Aug.	13,76	17,98	0,1602	0,1328
26. Sept.	11,69	17,75	0,1550	0,1376
1974				
3. Mai	2,43	3,98	0,0292	0,0332
10. Mai	5,71	6,87	0,0489	0,0510
16. Mai	11,36	14,30	0,0805	0,0898
19. Juni	24,70	26,66	0,1976	0,1784
26. Juni	28,01	26,85	0,2291	0,2050
25. Juli	21,05	20,74	0,2593	0,1681
29. Aug.	24,77	30,23	0,2845	0,2314
25. Sept.	24,08	26,30	0,2260	0,2040
1975				
2. Mai	1,96	2,15	0,0153	0,0269
14. Mai	12,78	15,02	0,0850	0,0798
4. Juni	23,44	27,58	0,1630	0,1707
29. Juni	20,01	27,42	0,1945	0,1962
20. Juli	18,16	27,92	0,1935	0,2167
		11,74*		0,0693*
19. Aug.	17,86	26,82	0,1977	0,1665
		11,37*		0,0762*
24. Sept.	21,12	28,51	0,2258	0,2380
		12,25*		0,0894*

* Fläche bzw. Gewicht neuer Blätter

Abb. 2. Zeitliche Veränderung der Fläche »mittlerer unbeschädigter« Blätter von *Quercus cerris* — 1975
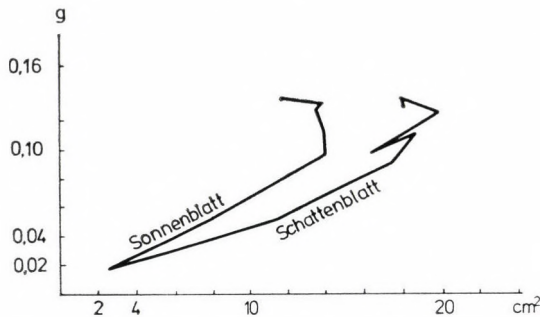
Abb. 3. Zusammenhang zwischen Fläche und Gewicht bei »mittleren unbeschädigten« Blättern von *Quercus cerris* — 1973

Vergleich von Fläche und Gewicht der Sonnen- und Schattenblätter

Trotz Raupenfraß, der das Wachstum schädlich beeinflußte, sind die Unterschiede in der photosynthetischen Tätigkeit von Sonnen- und Schattenblättern im Hinblick auf Flächen- und Gewichtsverhältnisse aussagekräftig.

Die erzielten dreijährigen Versuchsergebnisse zeigen eindeutig, daß die Fläche von Schattenblättern stets wesentlich größer und deren Wachstum intensiver ist als die der Sonnenblätter. Eine primäre Ursache dafür ist wohl, daß der in den oberen Laubkronenschichten besser wirksam werdende, stärkere, direkte Lichteinfall eine hemmende Wirkung auf das Flächenwachstum der Sonnenblätter ausübt. Es ist anzunehmen, daß bei der Ausbildung kleinerer Blattflächen nicht nur die Lichteinstrahlung, sondern auch der xerotherme Charakter der Mikroumwelt der Sonnenschicht eine Rolle spielen.
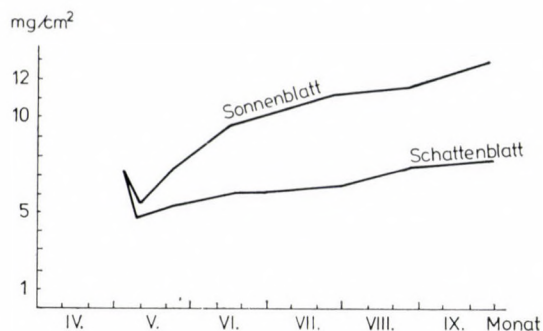
Abb. 4. Zeitliche Veränderung des auf eine Blattflächeneinheit entfallenden Gewichts bei *Quercus cerris* — 1973

Tabelle 4

Zeitliche Veränderung der auf die Flächeneinheit entfallenden Blattgewichte von Quercus cerris (mg/cm²)

Zeitpunkte	Sonnenblatt	Schattenblatt
1973		
4. Mai	7,10	7,10
10. Mai	5,40	4,80
24. Mai	7,40	5,40
13. Juni	9,50	6,10
27. Juni	10,20	6,10
27. Juli	11,30	6,50
23. Aug.	11,70	7,50
26. Sept.	13,10	7,90
1974		
3. Mai	12,60	8,80
10. Mai	9,10	8,10
16. Mai	7,20	6,20
29. Mai	6,70	5,50
19. Juni	7,90	7,10
26. Juni	8,10	7,50
25. Juli	12,10	7,90
29. Aug.	11,00	7,70
25. Sept.	9,50	7,90
1975		
2. Mai	8,00	7,40
14. Mai	6,90	5,70
4. Juni	7,60	6,40
29. Juni	9,80	7,20
20. Juli	10,70	7,90
		5,90*
19. Aug.	11,10	6,70
		6,70*
24. Sept.	10,70	8,60
		7,20*

* Gewichte von Blattflächeneinheiten neuer Blätter

Der Unterschied zwischen Sonnen- und Schattenblattfläche verstärkt sich ab Anfang Juni (Abb. 1), wird doch die Laubschichtung nach der Lichtintensität mit der Laubentfaltung und dem Schluß der Laubkrone immer ausgeprägter.

Trotz ihrer geringeren Fläche ist doch das Gewicht der Sonnenblätter stets höher als das der Schattenblätter; ihre Gewichtszunahme intensiver. Auf gleiche Flächenveränderung entfällt bei diesem stets eine größere Gewichtsveränderung, was die Darstellung der Flächen- und Gewichtsverhältnisse der Durchschnittsblätter veranschaulicht (Abb. 3).

Besonders auffallend sind die Unterschiede zwischen Sonnen- und Schattenblättern, wenn nicht die jahreszeitlichen Veränderungen der Flächen und Gewichte der »Durchschnittsblätter«, sondern die auf eine Blattflächeneinheit entfallenden Gewichte untersucht werden (Tabelle 4, Abb. 4). Ein Vergleich des Trockengewichts von Sonnen- und Schattenblättern gleicher Fläche ergibt stets einen höheren Gewichtsanteil der Sonnenblätter. Auffallend sind die höheren Gewichte im zeitigen Frühjahr in allen drei Jahren sowie deren Abfall vor dem späteren allmählichen Wachstum. Es kann angenommen werden, daß einerseits die aus den Knospen entwickelten kleinflächigen Blätter über Reservestoffe verfügen und diese andererseits unmittelbar nach ihrem Erscheinen noch nicht in der Lage sind, ihre normale Assimilationsfunktion zu erfüllen bzw. die Respirationsverluste im Trockengewicht auszugleichen.

Werden mit Ausnahme der ersten abfallende Daten die Wachstumsprozesse der Gewichtsveränderungen mit einer Sättigungskurve beschrieben (Sváb 1973), so sind Aufschlüsse über Abweichungen in der Wachstumsgeschwindigkeit von Sonnen- und Schattenblättern zu erhalten. Beim Vergleich der Regressionskoeffizienten der zu einer Geraden transformierten Funktionen kann festgestellt werden, daß deren Abweichung in einem Grenzwahrscheinlichkeit von 1% signifikante Werte zeigt (Tabelle 5). Die Gerade zeigt bei Sonnenblättern stets einen

Tabelle 5

Signifikanzuntersuchung der Abweichung der Regressionskoeffizienten (b) der zu Geraden transformierten Sättigungskurven ("b" = Regressionskoeffizient —, db = Abweichung der Regressionskoeffizienten —, s_d = Standardabweichung der Regressionskoeffizienten)

	db	t	s_d	FG
Quercus cerris				
$b_{Sonnenbl.}-b_{Schattenbl.}$	0,0093	4,65**	0,0020	8
Quercus petraea				
$b_{Sonnenbl.}-b_{Schattenbl.}$	0,0050	2,24*	0,0022	10
Sonnenblatt				
$b_{Qu.\ cerris}-b_{Qu.\ petr.}$	0,0059	3,41**	0,0017	9
Schattenblatt				
$b_{Qu.\ cerris}-b_{Qu.\ petr.}$	0,0016	0,65+	0,0024	9

\+ signifikant in einem Grenzwahrscheinlichkeit von 10%
* signifikant in einem Grenzwahrscheinlichkeit von 5%
** signifikant in einem Grenzwahrscheinlichkeit von 1%

steileren Verlauf, d.h. die Gewichtszunahme erfolgt in der Sonnenschicht schneller (Abb. 5). Die Wirksamkeit der Trockensubstanzproduktion ist in diesen besser, was auch der höhere Wert der oberen Grenze der Sättigungskurve anzeigt (Abb. 5). Der Energiegehalt der Sonnenblätter ist höher als der der Schattenblätter (Papp, L. B.—Papp, M. und Tóth 1976).
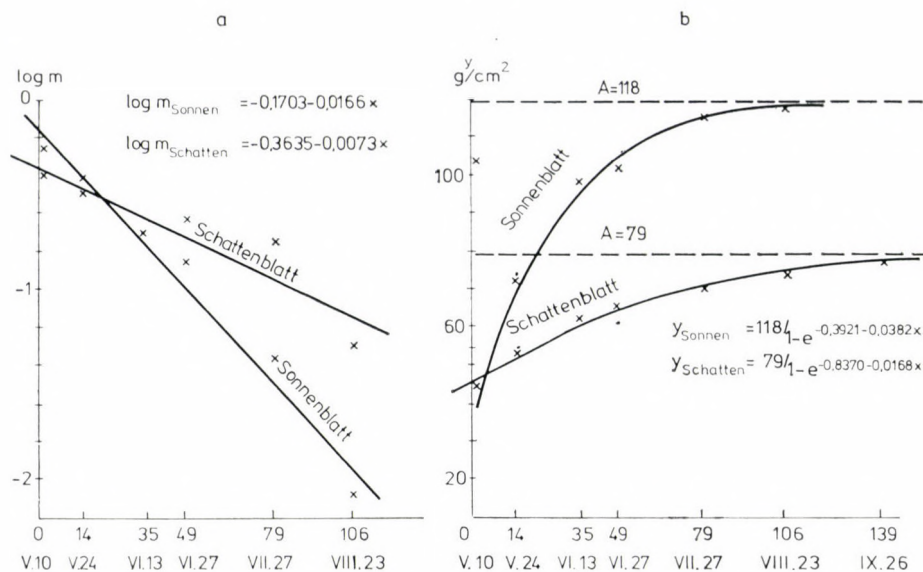
Abb. 5. Gewichtszunahme der Blattflächeneinheit von Sonnen- und Schattenblättern bei *Quercus cerris* — 1973. — a: Zur Geraden transformierte Sättigungskurve (m = relativer Unsättigungsgrad) — b: Sättigungskurve (A = obere Grenze; Meßwerte — + berechnete Daten)

Verlauf der Wachstumscharakteristika

Die Wachstumscharakteristika verlaufen bei Sonnen- und Schattenblättern zeitlich ähnlich (Tabelle 6).

Das Maximum von RGR- und NAR-Werten ist Anfang Mai, in der Phase intensiven Wachstums zu beobachten. Auch die LAR erreicht zu diesem Zeitpunkt bzw. 10—14 Tage später ihren höchsten Wert und zeigt während der Vegetationsperiode bis zu deren Ende fallende Tendenz. Eine Erklärung dafür ist, daß die endgültige Größe der Blattflächen rasch erreicht wird und danach hauptsächlich Gewichtszunahme erfolgt. Für den zeitlichen Verlauf von RGR und NAR ist charakteristisch, daß sie eine einer Exponentialkurve ähnliche Veränderung zeigen. Infolge der hohen LAR-Werte fällt deren Maximum im zeitigen Frühjahr plötzlich und stark ab, das Ausmaß dieses Abfalls wird immer geringer. Die niedrigen Werte der Charakteristika verändern sich ab Ende Juni kaum noch.

Ein wichtiger Faktor, der den NAR-Wert bestimmt, ist die Photosyntheseaktivität. Wahrscheinlich sind auch die NAR-Spitzenwerte im Frühjahr Folgen einer höheren Aktivität der Blätter, zu deren unmittelbarer Bestimmung wurden allerdings keine Messungen durchgeführt.

Der NAR-Abfall kann von zwei gegensätzlichen Tendenzen hervorgerufen werden. Mit dem Wachstum erhöht sich die Photosyntheseaktivität der Blätter, gleichzeitig nimmt aber auch die gegenseitige Beschattungswirkung der Blätter zu. Als deren Ergebnis sinkt die absorbierte Lichtmenge auf einer Blattflächeneinheit, was eine Einschränkung der Photosynthese bedeutet. In der NAR drückt sich wegen der lange Zeiträume umfassenden Probenentnahmen auch der Respirationsverlust aus. Daher spielt für die in der Sommerperiode charakteristischen außerordentlich niedrigen NAR-Werte sicher auch die gegenüber der Assimilation stärkere Geltung erlangende Atmung eine wichtige Rolle.
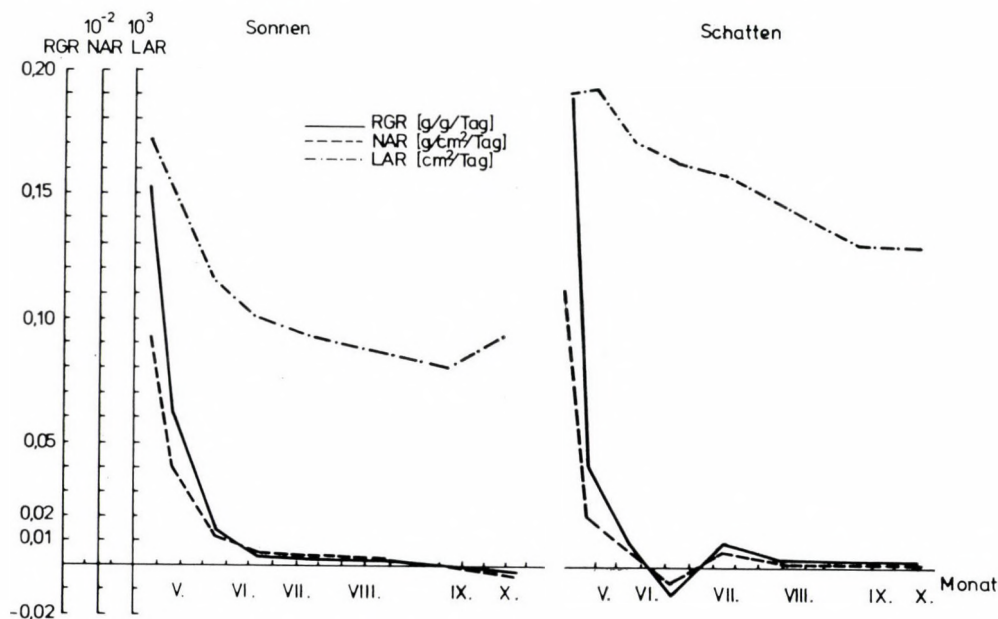
Abb. 6. Veränderung der Wachstumscharakteristika an Sonnen- und Schattenblättern von *Quercus cerris* — 1973

Die Geschwindigkeit des Flächenwachstums der Blätter und der Trockensubstanzzunahme ist in der zeitigen Vegetationsperiode am höchsten, was auch durch hohe $RLGR_A$- und RGR-Werte ausgedrückt wird. $RLGR_A$ weist ein höheres Maximum auf, und ihr Abfall ist im Vergleich zu RGR viel stärker. Dies macht den Unterschied in den Flächen- und Gewichtszunahmenprozessen deutlich.

Die Photosyntheseaktivität der nach dem Raupenbefall entwickelten jungen Blätter und ihr Wachstum ist im Vergleich zu den voll entwickelten Blättern höher. Damit im Zusammenhang steht z.B. der höhere positive Wert von NAR und RGR im Juni und Juli 1973, der sich hauptsächlich in der Schattenschicht zeigte (Abb. 6). Die neugebildeten jungen Blätter zeigten keine juvenilen Eigenschaften, ihr LAR-Wert ist relativ niedrig, und das ist der Grund dafür, daß die NAR im Juli geringfügig ansteigt.

Die hauptsächlich im Schattenniveau entwickelten neuen Blätter wichen in ihrer Morphologie und Funktion von den im Frühjahr und im Juli ausgebildeten Blättern ab. Durch erhöhte Assimilationstätigkeit ergänzten bzw. übernahmen sie die Funktion der beschädigten Blätter. Die hohen Wachstumscharakteristika der im Jahre 1975 von den voll entwickelten, alten Blättern getrennten jungen Blätter werden in Tabelle 6 und auf Abbildung 7 vorgestellt. Die NAR- und RGR-Werte von Juli und August kommen an die Frühjahrswerte dieser Charakteristika heran.

Vergleich der Wachstumscharakteristika von Sonnen- und Schattenblättern

Ein Vergleich des Verlaufs der Wachstumscharakteristika von Sonnen- und Schattenblättern erlaubt die Feststellung, daß die LAR-Werte bei Schattenblättern stets viel höher liegen. Eine Ursache dafür ist, daß ihre Fläche im Laufe des ganzen Jahres größer ist als die

Tabelle 6

Zeitliche Veränderung der Wachstumscharakteristika von Quercus cerris

	Sonnenblatt				Schattenblatt			
	RGR	NAR($\times 10^{-2}$)	LAR	RLGR	RGR	NAR($\times 10^{-2}$)	LAR	RLGR
1973								
4. 5.—10. 5.	0,1515	0,0921	171,45	0,1959	0,1887	0,1059	191,31	0,2534
10. 5.—24 5.	0,0602	0,0389	149,65	0,0381	0,0396	0,0204	192,84	0,0311
24. 5.—13. 6.	0,0138	0,0117	117,05	0,0013	0,0094	0,0054	172,94	0,0039
13. 6.—27. 6.	0,0041	0,0041	100,72	0,0001	—0,0105	—0,0065	164,09	—0,0100
27. 6.—27. 7.	0,0023	0,0025	93,11	—0,0009	0,0086	0,0054	159,00	0,0065
27. 7.—23. 8.	0,0018	0,0021	87,21	0,0006	0,0013	0,0009	144,82	—0,0036
23. 8.—26. 9.	—0,0010	—0,0012	80,74	—0,0049	0,0010	0,0008	132,13	—0,0003
1974								
3. 5.—10. 5.	0,0737	0,0733	104,22	0,1220	0,0613	0,0480	128,85	0,0779
10. 5.—16. 5.	0,0831	0,0641	131,92	0,1146	0,0943	0,0638	150,35	0,1221
16. 5.—29. 5.	0,1369	0,0252	147,12	0,0415	0,0441	0,0254	176,40	0,0546
29. 5.—19. 6.	0,0199	0,0146	135,25	0,0112	0,0054	0,0032	166,72	—0,0041
19. 6.—26. 6.	0,0211	0,0171	123,52	0,0179	0,0199	0,0142	139,56	0,0010
26. 6.—25. 7.	0,0043	0,0043	100,45	—0,0098	—0,0068	—0,0054	127,55	—0,0089
25. 7.—29. 8.	0,0026	0,0031	84,25	—0,0049	0,0091	0,0072	127,58	0,0114
29. 8.—25. 9.	—0,0085	—0,0089	95,69	—0,0010	—0,0047	—0,0036	129,83	—0,0051
1975								
2. 5.—14. 5.	0,1429	0,1006	146,95	0,1562	0,0906	0,0666	160,91	0,1619
14. 5.— 4. 6.	0,0310	0,0211	146,04	0,0288	0,0362	0,0209	170,05	0,0289
4. 6.—29. 6.	0,0070	0,0058	121,53	—0,0063	0,0055	0,0037	149,90	—0,0002
29. 6.—20. 7.	—0,0002	—0,00022	98,37	—0,0046	0,0047	0,0035	134,02	0,0008
20. 7.—19. 8.	0,0007	0,0008	92,07	—0,0005	—0,0087	—0,0061	142,84	—0,0013
					0,0031*	0,0020*	158,83*	—0,0010*
19. 8.—24. 9.	0,0036	0,0040	92,04	0,0046	0,0090	0,0072	136,78	0,0016
					0,0044*	0,0031*	142,63*	0,0020*

* Wachstumscharakteristika der neuen Blätter
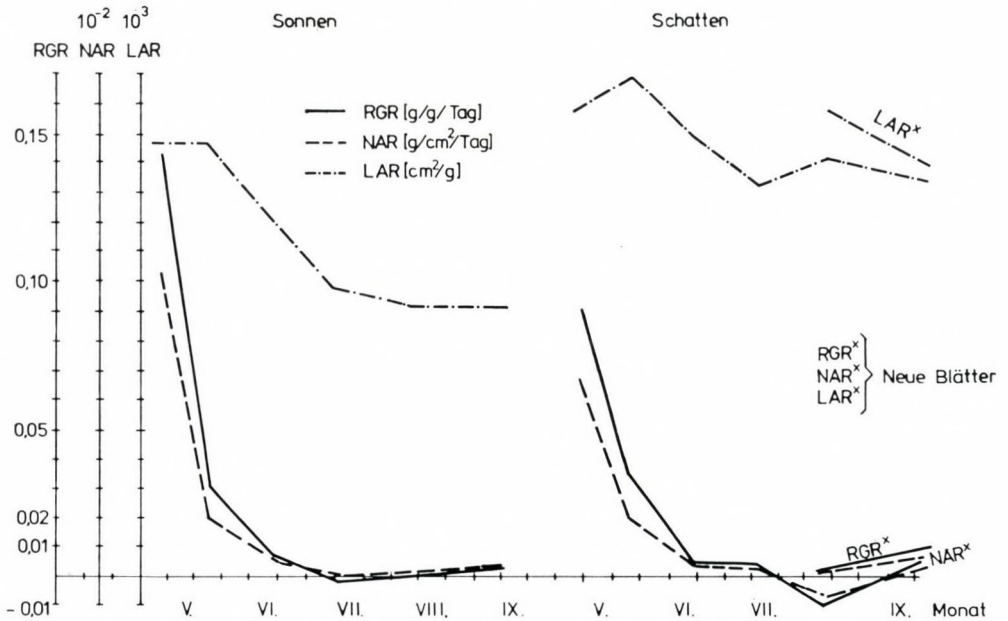
Abb. 7. Veränderung der Wachstumscharakteristika an Sonnen- und Schattenblättern von *Quercus cerris* — 1975

der Sonnenblätter, das Gewicht verhält sich umgekehrt. Vom oberen zum unteren Teil der Baumkronenschicht bzw. von den Sonnen- bis zu den Schattenblättern erhöht sich die LAR auf ungefähr das 1,8 fache.

Die Werte für NAR und RGR liegen in den Schattenblättern meist niedriger als in den Sonnenblättern. Der höheren LAR entsprechend ist auch der Abfall nach den Frühjahrsmaxima höher. Infolge Raupenfraß erlangte die vertikale Schichtung der Lichtintensität keine ausgesprochene Geltung. Die kleinere Fläche der jungen Blätter, ihr Gewicht und ihre verstärkte Assimilationstätigkeit hatten auch eine Schwankung von mittleren Flächen und Gewichten sowie im Sommer ein mehrmaliges Hochschnellen der RGR- und NAR-Werte zur Folge. Bei der Untersuchung des zeitlichen Verlaufs der beiden Wachstumscharakteristika ist die Analyse der Abweichungen nicht zuverlässig genug. Deshalb wurden anhand der im Frühjahr gemessenen Blattfläche und -gewicht sowie der zu Ende der Vegetationsperiode erreichten Fläche und Gewichtsproduktion der Blätter die für die einzelnen Jahre charakteristischen RGR- und NAR-Werte berechnet:

Tabelle 7

Jahresmittel der Wachstumscharakteristika von Sonnen- und Schattenblättern von Quercus cerris

Jahr	Sonnenblatt			Schattenblatt		
	RGR	$NAR^{10^{-2}}$	LAR	RGR	$NAR^{10^{-2}}$	LAR
1973	0,0150	0,0160	82,02	0,0142	0,0107	130,32
1974	0,0142	0,0144	103,87	0,0125	0,0100	127,65
1975	0,0185	0,0180	95,72	0,0144	0,0140	112,49
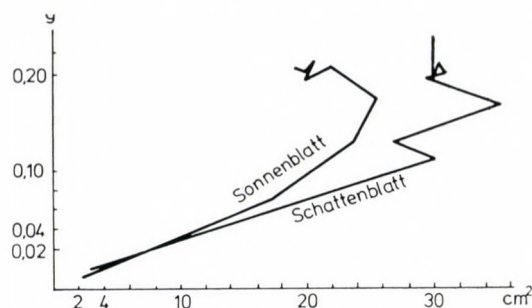
Abb. 8. Zusammenhang zwischen Fläche und Gewicht bei »mittleren unbeschädigten« Blättern von *Quercus petraea* — 1973
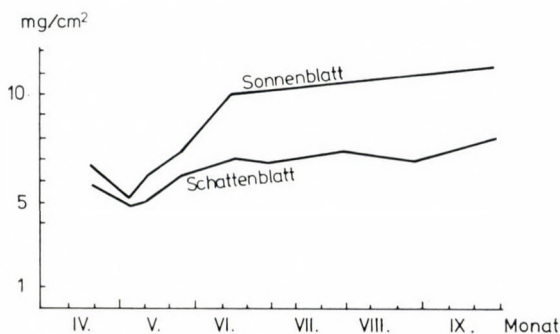
Abb. 9. Zeitliche Veränderung des auf eine Blattflächeneinheit entfallenden Gewichts bei *Quercus petraea* — 1973

Aus der Tabelle geht hervor, daß auch bei den Jahresmitteln stets im Falle der Schattenblätter die RGR- und NAR-Werte niedriger sind.

Bei der Untersuchung der Gewichtsveränderung wurde darauf hingewiesen, daß die Geschwindigkeit der Akkumulierung von organischer Substanz in den Schattenblättern geringer und auch deren Wirkungsgrad schwächer ist. Das wird auch von den Unterschieden zwischen RGR- und NAR-Werten bezüglich der Sonnen- und Schattenblätter unterstrichen.

Quercus petraea (Matt.) Liebl.

Flächen- und Gewichtsveränderungen

Die Blattflächen von *Quercus petraea* sind wesentlich größer als die von *Quercus cerris.* Hierbei handelt es sich um eine Artenspezifität. Die Laubentfaltung setzt im Vergleich zur Zerreiche um ungefähr zwei Wochen früher ein, und die Blätter erreichen eine dem Maximum nahekommende Fläche bereits gegen Ende Mai.

In der Veränderung der mittleren Flächen und Gewichte sind im Vergleich zu *Quercus cerris* größere Schwankungen festzustellen (Tabelle 8). Das ist eine Folge des stärkeren Raupenbefalls an den Blättern von *Quercus petraea;* die Ursache dafür ist einerseits im erwähnten phänologischen Unterschied, andererseits dagegen im abweichenden anatomischen Aufbau der Blätter beider Eichenarten zu suchen.

Die zeitliche Veränderung der Gewichtszunahme in den Blättern verhält sich bei *Quercus cerris* und *Quercus petraea* ähnlich. Das Maximum der mittleren Blattgewichte wurde bei Sonnen- und Schattenblättern gleichermaßen Ende Juli und im August festgestellt, wie das auch bei *Quercus cerris* der Fall ist.

Innerhalb der Art zeigen sich gut ausgeprägte Unterschiede zwischen Flächen- und Gewichtszunahme der Sonnen- und Schattenblätter bei *Quercus petraea* ähnlich wie bei *Quercus cerris* (Tabellen 8, 9; Abb. 8, 9, 10).

Tabelle 8

Zeitliche Veränderung von Fläche und Gewicht mittlerer unbeschädigter Blätter von Quercus petraea

Zeitpunkte	Fläche (cm^2)		Gewicht (g)	
	Sonnebl.	Schattenbl.	Sonnenbl.	Schattenbl.
1973				
18. April	2,28	3,11	0,0143	0,0204
4. Mai	17,29	29,99	0,0918	0,1310
10. Mai	23,86	26,64	0,1488	0,1475
24. Mai	25,61	35,54	0,1899	0,1834
13. Juni	22,01	29,42	0,2231	0,2119
27. Juni	20,20	31,11	0,2121	0,2158
27. Juli	20,90	30,18	0,2306	0,2297
23. Aug.	20,09	30,08	0,2202	0,2092
26. Sept.	19,18	30,17	0,2245	0,2529
1974				
27. April	7,74	13,94	0,0495	0,0658
3. Mai	12,78	29,04	0,0769	0,1516
10. Mai	24,36	32,10	0,1605	0,1902
16. Mai	18,49	27,42	0,1381	0,1682
29. Mai	20,91	32,20	0,1679	0,2416
19. Juni	23,33	29,39	0,2089	0,2231
	12,27*	22,50*	0,0687*	0,1283*
26. Juni	23,66	28,99	0,2168	0,2353
	11,76*	27,22*	0,0788*	0,1606*
25. Juli	18,34	28,66	0,2226	0,2304
		15,14*		0,0976*
29. Aug.	20,92	26,48	0,2362	0,2468
		18,39*		0,1269*
25. Sept.	23,82	29,13	0,2447	0,2570
	17,01*	25,51*	0,1480*	0,1888*
1975				
23. April	5,99	5,39	0,0405	0,0353
2. Mai	20,04	21,84	0,0912	0,0866
14. Mai	25,81	30,02	0,1912	0,0866
4. Juni	30,14	30,48	0,2471	0,1966
29. Juni	25,81	29,41	0,2665	0,2328
	14,72*	18,36*	0,0854*	0,0810*
20. Juli	20,45	25,60	0,2021	0,2066
	20,54*	21,78*	0,1755*	0,1185*
19. Aug.	24,22	27,76	0,2236	0,2409
	15,25*	18,53*	0,1373*	0,1072*
24. Sept.	23,66	33,22	0,2604	0,2905
	24,45*	24,67*	0,2333*	0,1699*

* Fläche bzw. Gewicht der neuen Blätter
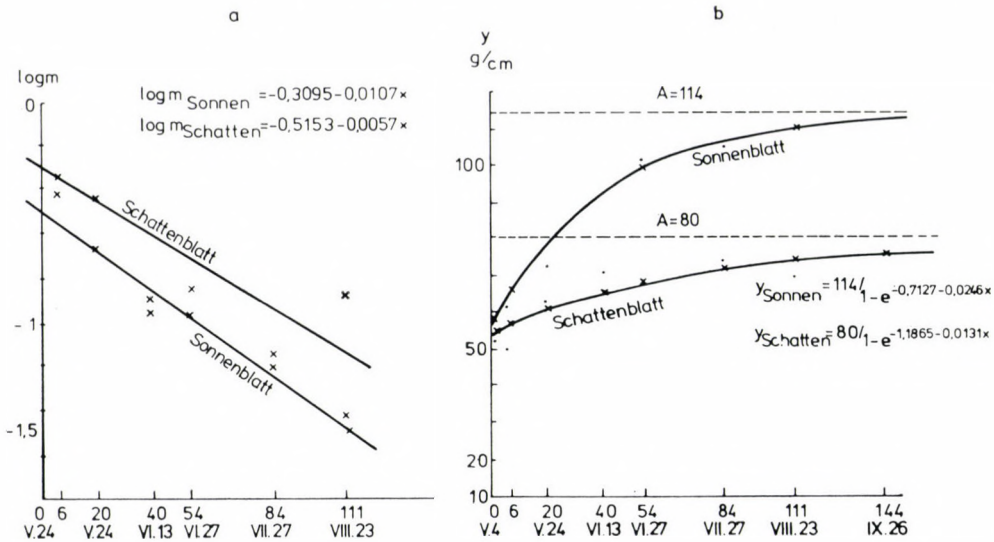
Abb. 10. Gewichtszunahme der Blattflächeneinheit von Sonnen- und Schattenblättern bei *Quercus petraea* — 1973; — a: Zur Geraden transformierte Sättigungskurve (m = relativer Unsättigungsgrad) — b: Sättigungskurve (A = obere Grenze; Meßwerte; + berechnete Daten)
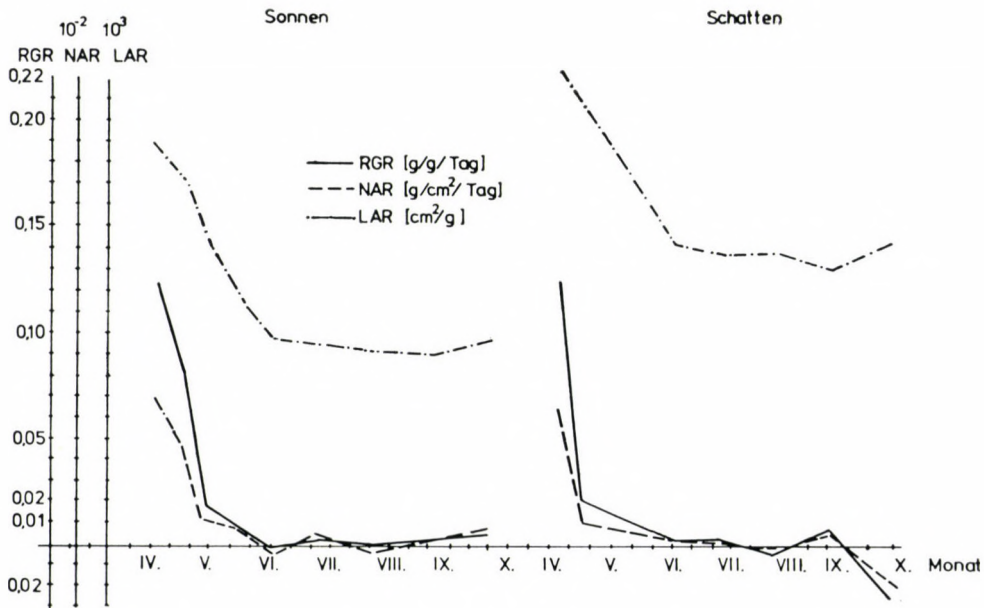
Abb. 11. Veränderung der Wachstumscharakteristika an Sonnen- und Schattenblättern — 1973

Veränderung der Wachstumscharakteristika

Bei Sonnen- und Schattenblättern von *Quercus petraea* können bezüglich des zeitlichen Verlaufs der Wachstumscharakteristika (Tabelle 10, Abb. 11) zu *Quercus cerris* ähnliche Feststellungen getroffen werden.

Bei vorliegender Art ist allerdings die LAR stets viel höher als bei *Quercus cerris.* Deren Wert erhöht sich in der Richtung von Sonnenblättern zu Schattenblättern fortschreitend wegen

Tabelle 9

Zeitliche Veränderung der auf die Blattflächeneinheit entfallenden Gewichte (mg/cm²) von Quercus petraea

Zeitpunkte	Sonnenbl.	Schattenbl.
1973		
18. April	6,70	5,80
4. Mai	5,20	4,80
10. Mai	6,20	5,00
24. Mai	7,30	6,30
13. Juni	10,00	7,10
27. Juni	10,20	6,90
27. Juli	10,60	7,50
23. Aug.	11,00	7,00
26. Sept.	11,40	8,10
1974		
27. April	6,40	4,70
3. Mai	6,10	5,10
10. Mai	6,60	5,90
16. Mai	7,50	6,00
29. Mai	8,10	7,50
19. Juni	8,90	7,60
	5,60*	5,70*
26. Juni	9,20	8,10
	6,70*	5,90*
25. Juli	12,00	8,10
		6,50*
29. Aug.	11,30	9,60
		6,90*
25. Sept.	10,30	8,80
	8,70*	7,40*
1975		
23. April	6,80	6,50
2. Mai	4,50	4,00
14. Mai	7,50	5,90
4. Juni	8,20	6,50
29. Juni	10,30	7,90
	5,80*	4,50*
20. Juli	10,00	8,10
	8,50*	5,30*
19. Aug.	9,40	8,70
	9,00*	5,80*
24. Sept.	11,00	8,80
	9,30*	6,70*

* Gewichte von Flächeneinheiten neuer Blätter

Tabelle 10

Zeitliche Veränderung der Wachstumscharakteristika von Quercus petraea

	Sonnenblatt				Schattenblatt			
	RGR	NAR($\times 10^{-2}$)	LAR	RLGR	RGR	NAR($\times 10^{-2}$)	LAR	RLGR
1973								
18. 4.—4. 5.	0,1162	0,0654	184,44	0,1266	0,1162	0,0583	218,62	0,1416
4. 5.—10. 5.	0,0804	0,0466	171,03	0,0536	0,0197	0,0097	203,33	—0,0197
10. 5.—24. 5.	0,0174	0,0119	146,05	0,0050	0,0155	0,0083	187,91	0,0205
24. 5.—13. 6.	0,0080	0,0070	115,30	—0,0075	0,0072	0,0044	164,33	—0,0094
13. 6.—27. 6.	—0,0036	—0,0037	96,98	—0,0061	0,0013	0,0009	141,52	0,0039
27. 6.—27. 7.	0,0027	0,0030	92,83	0,0011	0,0020	0,0015	137,57	—0,0010
27. 7.—23. 8.	—0,0017	—0,0019	90,92	—0,0014	—0,0034	—0,0025	137,29	—0,0001
23. 8.—26. 9.	0,0005	0,0007	88,30	—0,0014	0,0057	0,0044	130,38	0,0001
1974								
27. 4.—3. 5.	0,0734	0,0454	162,34	0,0835	0,1391	0,0695	197,70	0,1223
3. 5.—10. 5.	0,1051	0,0665	156,4	0,0921	0,0324	0,0181	178,87	0,0143
10. 5.—16. 5.	—0,0250	—0,0175	143,50	—0,0459	—0,0204	—0,0123	166,07	—0,0262
16. 5.—29. 5.	0,0150	0,0117	128,75	0,0094	0,0278	0,0190	145,48	0,0123
29. 5.—19. 6.	0,0104	0,0088	117,41	0,0052	—0,0037	—0,0029	132,52	—0,0043
19. 6.—26. 6.	0,0053	0,0048	110,38	0,0020	0,0076	0,0060	127,35	—0,0019
					0,0320*	0,0186*	172,10*	0,0272*
26. 6.—25. 7.	0,0009	0,0010	95,58	—0,0087	—0,0007	—0,0006	123,77	—0,0004
					—0,0171*	—0,0105*	164,05*	—0,0006*
25. 7.—29. 8.	0,0016	0,0020	85,57	0,0037	0,0019	0,0017	115,52	—0,0022
					0,0075*	0,0050*	149,35*	0,0055*
29. 8.—25. 9.	0,0013	0,0014	93,03	0,0048	0,0015	0,0014	110,38	0,0035
					0,0147*	0,0105*	139,05*	0,0121*
1975								
23. 4.—2. 5.	0,0901	0,0484	197,64	0,1341	0,0997	0,0485	223,37	0,1554
2. 5.—14. 5.	0,0629	0,0376	160,65	0,0210	0,0589	0,0288	197,78	0,0265
14. 5.—4. 6.	0,0114	0,0090	126,78	0,0073	0,0053	0,0033	162,54	0,0007
4. 6.—29. 6.	0,0030	0,0028	108,93	—0,0062	0,0067	0,0048	139,47	—0,0014
29. 6.—20. 7.	—0,0131	—0,0133	98,71	—0,0110	—0,0056	—0,0045	125,19	—0,0066
	0,0343*	0,0246*	135,14*	0,0158*	0,0181*	0,0089*	201,20*	0,0081*
20. 7.—19. 8.	—0,0033	—0,0032	104,93	0,0056	0,0051	0,0043	119,24	0,0027
19. 8.—24. 9.	0,0042	0,0043	98,92	—0,0006	0,0052	0,0045	114,75	0,0049
	0,0147*	0,0137*	107,12*	0,0131*	0,0127*	0,0081*	114,75*	0,0079*

* Wachstumscharakteristika der neuen Blätter

der abweichenden Flächen- und Gewichtsverhältnisse beider Arten sowie deren unterschiedlichen ökologischen Ansprüchen in geringerem Maße als bei *Quercus cerris*, maximal nur auf das 1,6 fache.

Die Maxima der NAR und RGR der Blätter sind bereits Ende April festzustellen. Diese Erscheinung hängt mit einer früheren Belaubung und dem Einsetzen der Photosynthesetätigkeit zusammen. Bei dieser Art ist die Tageseffizienz der Netto-Assimilation (NAR) in Sonnenblättern höher und auch der Vorgang der Gewichtserhöhung (RGR) verläuft rascher. Diese Beobachtungen werden auch von den für einzelne Jahre charakteristischen Mittelwerten der Wachstumsraten unterstützt:

Tabelle 11

Vergleich der Blattwachstumsvorgänge von Quercus petraea und Quercus cerris

Jahr	Sonnenblatt			Schattenblatt		
	RGR	$NAR^{10^{-2}}$	LAR	RGR	$NAR^{10^{-2}}$	LAR
1973	0,0172	0,0166	89,86	0,0157	0,0122	121,77
1974	0,0158	0,0090	107,27	0,0090	0,0061	133,42
1975	0,0121	0,0111	98,53	0,0137	0,0108	118,50

Vergleichung der Wachstumsprozesse der Blätter von Quercus petraea und Quercus cerris

Bei einem Vergleich beider Arten anhand der Untersuchungen kann festgestellt werden, daß diese im Hinblick auf ihre Wachstumsvorgänge zahlreiche gemeinsame Züge aufweisen. Trotz der Ähnlichkeiten lassen sich zwischen den Arten auch gut bemerkbare Unterschiede nachweisen:

1. Beim Vergleich der Gewichte von Blattflächeneinheiten beider Eichenarten (Tabelle 12) kann festgestellt werden, daß bei den Schattenblättern sehr

Tabelle 12

Jahresmittel des Gewichtes (mg/cm^2) von Blattflächeneinheiten von Quercus cerris und Quercus petraea

Sonnenblätter (mg/cm^2)	*Quercus cerris*	*Quercus petraea*
1973	9,50	8,70
1974	9,40	8,60
1975	9,30	8,50
Schattenblätter (mg/cm^2)	***Quercus cerris***	***Quercus petraea***
1973	6.40	6.50
1974	7,40	7,10
1975	7,10	7,10

ähnliche, bei den Sonnenblättern dagegen konsequent für *Quercus cerris* höhere Werte erhalten wurden:

2. Die Gewichtsveränderungen wurden mit Hilfe einer Sättigungskurve erfaßt, und durch den Vergleich der Koeffizienten der Regressionsgeraden (b) erhielten wir Aufschluß über Abweichungen in der Wachstumsgeschwindigkeit zwischen den Arten (Tabelle 5).

Mit Hilfe der t-Probe wurde festgestellt, daß in den Sonnenblättern der Unterschied in der Wachstumsgeschwindigkeit zwischen beiden Arten in einem Grenzwahrscheinlichkeit von 10% signifikant ist, bei Schattenblättern besteht dagegen in der Intensität der Gewichtszunahme kaum ein Unterschied.

In den Sonnenblättern von *Quercus cerris* verläuft die Gewichtszunahme rascher (die Gerade ist steiler), und deren Wirksamkeit ist auch höher (die obere Grenze liegt höher).

3. In den Schattenblättern sind auch die RGR- und NAR-Werte bei beiden Arten nahezu gleich, während in Sonnenblättern diese stets bei *Quercus cerris* höher sind (Tabellen 7, 11). Anhand der mit verschiedenen Näherungsverfahren erhaltenen übereinstimmenden Ergebnissen wurde angenommen, daß die Photosyntheseaktivität, die Effizienz der Assimilationstätigkeit und die Geschwindigkeit der Trockensubstanzproduktion in Sonnenblättern von *Quercus cerris* höher sind. Der Energiegehalt dieser Blätter ist höher als der ähnlicher Blätter von *Quercus petraea* (4,95 kcal bzw. 4,83 kcal, Papp, L. B., Papp, M. und Tóth 1976). In den Sonnenblättern von *Quercus cerris* wird die im Vergleich zu *Quercus petraea* höhere Photosynthesetätigkeit auch durch die Bildung mächtigerer assimilierender Gewebeschichten, hauptsächlich entwickelterer Palisadenparenchymschichten ermöglicht.

Vergleichende Analyse der Ergebnisse von drei Untersuchungsjahren

Flächen- und Gewichtsveränderung der Blätter von zwei Eichenarten wurden drei Jahre lang 8—10mal jährlich an Blättern der Sonnen- und Schattentriebe der Laubkrone untersucht. Zur vergleichenden Analyse der drei Jahre (bezüglich Blattfläche und -gewicht) wurde multivariable Varianzanalyse durchgeführt (Tabelle 13).

Es wurde die Hypothese aufgestellt, daß in den Versuchen die Jahre (A), Zeitpunkte (B) und die Lage der Blätter in Schichten mit unterschiedlichem Strahlungsangebot (C) die Flächen- und Gewichtsdaten beeinflussen, und in ihrer Varianz neben dem zufälligen Fehler die Wirkungen der erwähnten Faktoren und deren in verschiedenen Kombinationen auftretende Wechselwirkungen zum Ausdruck kommen.

Bei beiden Arten wurde folgendes festgestellt:

I. 1. Der Mittelwert von Blattfläche und -gewicht kann in allen drei Probenentnahmejahren als gleich betrachtet werden.

Tabelle 13

Ergebnisse der Varianzanalyse

Fläche unbeschädigter Blätter	*Quercus cerris*	*Quercus petraea*
A Jahre	***	ns
B Zeitpunkte	***	***
C Sonnen- und Schattenblätter	***	***
A × B	**	*
A × C	ns	**
B × C	ns	ns
A × B × C	ns	ns

Gewicht unbeschädigter Blätter	*Quercus cerris*	*Quercus petraea*
A Jahre	***	ns
B Zeitpunkte	***	***
C Sonnen- und Schattenblätter	**	ns
A × B	***	ns
A × C	ns	+
B × C	ns	ns
A × B × C	ns	ns

*** signifikant in einem Grenzwahrscheinlichkeit von 0,1%
* signifikant in einem Grenzwahrscheinlichkeit von 1%
* signifikant in einem Greznwahrscheinlichkeit von 5%
+ signifikant in einem Grenzwahrscheinlichkeit von 10%
ns nicht signifikant

2. Im Mittel der Zeitpunkte und Jahre wurden signifikante Unterschiede in der Fläche von Sonnen- und Schattenblättern beobachtet.

3. Im Mittel der Zeitpunkte erreichen die den Flächen entsprechenden Gewichte der Sonnen- und Schattenblätter in keinem Jahr in einem Grenzwahrscheinlichkeit von 5% einen akzeptablen Unterschied. Das kann auch ausdrücken, daß das Gewicht der geringerflächigen Sonnenblätter — wegen des in ihnen stattfindenden intensiveren Gewichtszunahmeprozesses — den Mittelwert der Gewichte von größerflächigen Schattenblättern erreicht oder signifikant übersteigt.

4. Der Mittelwert der Blattflächen zeigt bezüglich Sonnen- und Schattenblätter lediglich zwischen den ersten drei bzw. vier Probenentnahmezeitpunkten einen signifikanten Unterschied. Im Flächenwachstum der Blätter von *Quercus petraea* ist bereits ab Mitte Mai, bei *Quercus cerris* dagegen ab Anfang Juni kaum Veränderung festzustellen bzw. die Zunahme ist für einen akzeptablen Unterschied nicht ausreichend.

Ein signifikanter Unterschied der Fläche von Sonnen- und Schattenblättern besteht bei *Quercus petraea* ab Mitte Mai, bei *Quercus cerris* ab Mitte Juni. Das steht im Zusammenhang mit einer immer stärkeren Schließung der Laubkrone, hauptsächlich der Veränderung der Lichtverhältnisse.

Die Gewichtszunahme ist ein im Vergleich zur Flächenzunahme langsamerer Vorgang. In allen drei Jahren unterscheiden sich nur die Gewichte jedes zweiten aufeinander folgenden Probenentnahmezeitpunktes in beiden Lichtversorgungsschichten signifikant.

II. 1. Auf Flächen- und Gewichtsvarianzen übten unter den drei untersuchten Faktoren (Jahr, Probenentnahmenzeitpunkte, Lage in Sonnen- und Schattenbereich) die Probenentnahmezeitpunkte die größte Wirkung aus (Tabelle 13).

2. Die Jahre und Zeitpunkte beeinflussen nicht die Wirkung von Sonnen- und Schattenniveaus auf Flächen- und Gewichtsvarianzen. (Zwischen den Faktoren A—C und B—C wurde keine Wechselwirkung beobachtet.)

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LITERATUR

ANDO, T. (1965): Estimation of dry-matter production and growth-analysis of the young stand of Japanese black pine (Pinus thunbergii). Advancing Frontiers of Plant Sci., New Delhi, **10,** 1—10.

BLACKMAN, V. H. (1919): The compound interest law of plant growth. Ann. Bot. Lond. **33,** 353—360.

BLACKMAN, G. E. (1968): The application of the concepts of growth analysis to the assessment of productivity. In: Functioning of terrestrial ecosystems at the primary production level (ECKARDT, F. E. ed.). UNESCO Copenhagen, 243—259.

BLACKMAN, G. E.—KEMP, A. W. (1955): Physiological and ecological studies in the analysis of plant environment. X. An analysis of the effects of seasonal variation in daylight and temperature on the growth of Helianthus annuus in the vegetative phase. Ann. Bot. Lond. N. S. **19,** 527.

BLACKMAN, G. E.—WILSON, G. L. (1951): Physiological and ecological studies in the analysis of plant environment. VII. An analysis of the differential effects of light intensity on the net assimilation rate, leaf area ratio and relative growth rate of different species. Ann. Bot. Lond. N. S. **15,** 373—408.

BRIGGS, G. E.—KIDD, F.—WEST, C. (1920): A quantitative analysis of plant growth. I—II. Ann. Appl. Biol. **7,** 103—123; 202—223.

CARLISLE, A.—BROWN, A. H. F.—WHITE, E. J. (1966): The litter fall, leaf production and effects of defoliation by Tortrix viridana in a sessile oak (Quercus petraea) woodland. J. Ecol. **54,** 65—85.

COOMBE, D. E. (1960): An analysis of the growth of Trema quieneensis. J. Ecol. **48,** 219—221.

CZELLÁR, S.—B. PAPP, L. (1975): Lichtplanimeter zur Blattflächenmessung. Acta Biol. Debrecina **12,** 145—147.

EGED, S.—KOLEK, J.—DUDA, M. (1970): Seasonal changes in the growth and values of the NAR within sunflower and bean. Res. Project BÁB., Progr. Rep. I. p. 117—127, Bratislava.
EVANS, G. C. (1972): The quantitative analysis of plant growth. Stud. in Ecol., 1. 44—46; 133—139. Blackwell Sci. Publ., Oxford—London—Edinburg—Melbourne.
EVANS, G. C.—HUGHES, A. P. (1960): Plant growth and aerial environment I. Effect of artificial shading on Impatiens parviflora. New Phytol. **60,** 150—180.
FARMER, R. E. (1975): Growth and assimilation rate of juvenile norther red oak. Effects of light and temperature. Forest Sci. **21,** 373—381.
FISHER, R. A. (1920): Some remarks on the methods formulated in a recent article on "the quantitative analysis of plant growth". Ann. Appl. Biol. **7,** 367—372.
GREGORY, F. G. (1917): Physiological conditions in cucumber houses. Cheshunt (England) Exp. and Res. Sta. 3rd. Annual Report, 19—28.
GREGORY, F. G. (1926): The effect of climatic conditions on the growth of barley. Ann. Bot. **40,** 1—26.
HUGHES, A. P.—FREEMAN, P. R. (1967): Growth analysis using frequent small harvests. J. Appl. Ecol. **4,** 553—560.
HUNT, L. A.—COOPER, J. P. (1967): Productivity and canopy structure in seven temperate forage grasses. J. Appl. Ecol. **4,** 437—457.
HUXLEY, P. A. (1967): The effects of artificial shading on some growth characteristics of Arabica and Robusta coffee seedlings. I. The effects of shading on dry weight, leaf area and derived growth data. J. Appl. Ecol. **4,** 291—308.
JAKUCS, P. (1973): Síkfőkút — Project. Umweltbiologische Forschungen in einem Quercetum petraeae-cerris — Ökosystem im Rahmen des Biosphären-Programms. MTA Biol. Oszt. Közl. **14,** 11—25.
JAKUCS, P.—VIRÁGH, K. (1975): Changes in the area and weight of light- and shade adapted leaves and shoots of Quercus petraea and Quercus cerris in a Hungarian oak forest ecosystem. Acta Bot. Acad. Sci. Hung. **21,** 25—36.
JARVIS, P. G.—JARVIS, S. M. (1964): Growth rates of woody plants. Physiol. Plant. **17,** 654—666.
KUBIČEK, F. (1971): Leaf area estimation in Quercus petraea using linear regression equation. Photosynthetica **5/4,** 426—428.
KVĚT, J.—MARSHALL, J. K. (1971): Assessment of leaf area and other assimilating plant surfaces. In: Plant photosynthetic production, Manual of methods (ŠESTÁK, Z.—ČATSKÝ, Z.—JARVIS, P. G. eds.), 517—555, Netherlands, Hague.
MAGGS, D. H. (1960): The effects of number of shoots on the quantity and distribution of increment in young-apple-trees. Ann. Bot. N. S. **24,** 345—355.
PAPP, L. B.—PAPP, M.—TÓTH, J. (1976): Strukturcharakterisierung eines autotrophen Subsystems des Ökosystems eines ungarischen klimazonalen Eichenwaldes anhand der Untersuchung von Phytomasse-, Energie- und Bioelementgehalt (Síkfűkút-Project). Akad. Preisausschreiben. Debr. Mskr.
RADFORD, P. J. (1967): Growth analysis formulae, their use and abuse. Crop Sci. **7,** 171—174.
REES, A. R. (1963): Relationship between crop growth rate and leaf area index in the oil palm. Nature, **197,** 63—64.
SVÁB, J. (1973): Biometrische Methoden in der landwirtschaftlichen Forschung. Mezőgazd. Kiadó, Budapest.
VERNON, A. J.—ALLISON, J. C. S. (1963): A method of calculating net assimilation rate. Nature **200,** 814.
WATSON, D. J. (1952): The physiological basis of variation in yield. Adv. Agron. **4,** 101—142.
WATSON, D. J. (1958): The dependence of net assimilation rate on leaf area index. Ann. Bot. N. S. **22,** 37—54.
WATSON, D. J.—WITTS, K. J. (1959): The net assimilation rates of wild and cultivated beets. Ann. Bot. N. S. **23,** 431—439.
WHITEHEAD, F. F.—MYERSCOUGH, P. J. (1962): Growth analysis of plants. The ratio of mean relative growth rate to mean relative rate of leaf area increase. New Phytol. **61,** 314—321.
WILLIAMS, R. F. (1946): The physiology of plant growth with special reference to the concept of NAR. Ann. Bot. N. S. **10,** 41—72.

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NOTICE: SIXTH SYMPOSIUM ON LIVING AND FOSSIL DIATOMS BUDAPEST, HUNGARY. SEPTEMBER 1—6, 1980.

This is the first announcement for the Symposium on Living and Fossil Diatoms to be held on September 1—6, 1980 at the Hungarian Geological Society in Budapest, Hungary. Scientists working on the morphology, ecology, biostratigraphy and taxonomy of Living and Fossil Diatoms are invited to attend the symposium and to present papers or demonstrate their work. Deadline for abstracts, March 1, 1980. For preliminary registration and submission of titles of contributed papers mail to DR. MÁRTA HAJÓS, Hungarian Geological Survey Budapest, Post Box, 106. Hungary 1442.

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RECENSIONES

M. LITTLE, N. PAWELETZ, C. PETZELT, H. PONSTIGL, D. SCHROETER, H.-P. ZIMMERMANN, (eds): Mitosis: Facts and Questions. 1977, pp. 253. SPRINGER-Verlag; Berlin, Heidelberg, New York.

An informal discussion of mitosis led a small group of research workers to organize a meeting on this topic. For this reason the workshop "Mitosis: Facts and Questions" was held at the German Cancer Research Center in Heidelberg from April 25—29, 1977. Nine introductory lectures were given for the main topics followed by extensive discussions of facts and problems. The experiments in progress were presented as poster demonstrations. In this volume of the "Proceedings in Life Sciences" series the introductory lectures, discussions and poster abstracts are published by the SPRINGER-Verlag, on paper of excellent quality.

The first Session deals with "The Timing of Cell Cycle Events" presented by J. M. MITCHISON. The author considers "here not what happens but why it happens, in the sense of what signal for division is received by a growing cell". In his laboratory the division control is studied in the fission yeast *Schizosaccharomyces* pombe. After description of the yeast and the cell cycle events the role of cell size in division control is considered. The described results suggest a sizer control operating on division. To resolve this problem size mutants were isolated and the effect of nutrient shifts was studied. The results provide evidence for sizers operating at the time of nuclear division. It is considered DNA synthesis and the sizer may control the changes in growth rate, too.

"Surface signals and cellular regulation of growth" is written by C. M. EDELMAN, P. D'EUSTACHIO, D. A. MCCLAIN and S. M. JAZWINSKI. The first part is this paper summarizes the evidence for the existence of cellular structures that mediate the transmembrane control events. Specific cell surface receptor proteins are submitted to anchorage modulation. An appropriate surface — modulating assembly is involved in this process. All of the data discussed provide evidence for participation of components of surface — modulating assembly in growth control of normal cells. In transformed cells alteration of the surface — modulating assembly is important. Finally, the authors deal with the problem of initation of DNA replication, and they describe a useful assay to define cytoplasmic activators of DNA synthesis that appear to be subjected to growth control.

In Section 3, H. FUGE discusses the "Ultrastructure of Mitotic Cells". To understand the function of the mitotic mechanism a knowledge of the fine structure of mitotic cells and types of spindle microtubules is indispensable. First, organization of mitotic spindles of low eukaryotes is described. The Author gives in detail the extranuclear spindle formation of *Dinophyceae* as well as hypermastigote flagellates, the occurrence of intranuclear and "open" cell division as well as intranuclear spindle organization. The next parts of the paper deal with organization of the mitotic spindle in higher plants and animals. The data clearly show the role of microtubule organization centers in spindle formation and the process of arrangement, as well as, distribution of spindle microtubules during meta- and anaphase. Data are given for differences between higher plant and animal cells.

Problems of the "Microtubule — Organizing Centers of the Mitotic Spindle" are presented by G. G. BORISY and R. R. GOULD. In the fourth Section recent research on the spatial regulation of microtubule assembly in mitotic cells is presented. This process appears to be controlled by post-translational mechanisms. There are microtubules that form spontaneously by self-assembly requiring some diffusible nontubulin factors. On the other hand, there are microtubules whose site-initiated assembly is initiated by a nondiffusible mucleating element.

These results suggest that formation of the mitotic spindle involves some microtubule — organizing centers. The role of centrosomes and kinetochores in the organization of microtubules of the mitotic spindle is also discussed.

Section 5 is written by J. W. SANGER: "Nontubulin Molecules in the Spindle". The finding of the cytoplasmic contractile proteins suggest their important role in cell motility. Actin and myosin like proteins could be detected in the spindle apparatus of nonmuscle cells. Electron microscopic techniques, fluorescent and immunofluorescent probes are the useful methods for detecting the actin and myosin-like protein in the mitotic cells. On the basis of the recent experimental results, explanations for chromosome movement of mitotic cells are given.

Section 6 includes a study of "Mitosis in Differentiation, Morphogenesis, and Cancer" presented by F. DUSPIVA. "The question arises whether the only purpose of mitosis is to distribute, as perfectly as possible, the genome from the mother cell to the daughter cells, or has mitosis additional functions essential for differentiation" and morphogenesis. The second concept is supported by the role of spindle axis in orientation in differentiation. Processes of morphogenesis involve differential mitoses. Due to the differential mitosis a derivation in phenotype of cell populations occurs. The differential mitosis is influenced by specific cytoplasmic determinants. The nuclear-cytoplasmic interactions can influence the morphogenetic capacity of nuclei. The author emphasises the role of cell cycle research concerning differentiation. Finally, the problems of differentiation and cancer as a special case of dedifferentiation are discussed.

R. B. NICKLAS focuses on chromosome movements of mitosis presenting the Session 7. "Chromosome Movement: Facts and Hypotheses." The author reviews the current status of three general types of hypotheses explaining chromosome movements in anaphase. In prometaphase, however, the chromosome movements may be controlled by different mechanisms. It is important "to understand the regulation of the motors, especially in the control of chromosome velocity and of Congression in prometaphase".

The paper of J. R. MCINTOSH includes a study on "Mitosis in vitro: Isolates and Models of the Mitotic Apparatus" (Session 8). In the introduction an excellent glossary of the specific terms is given. A clear description of the terms helps us to understand this topic of cytology. The author reviews the isolation of the mitotic apparatus, the spindle and also some experimental spindle model systems. The experimental descriptions are followed by a discussion of spindle models to explain the spindle regulation mechanisms.

In the last session "Future Research on Mitosis" is discussed by D. MAZIA. Study of mitosis is inseparable from events of the whole cell cycle. The whole mitotic cycle can be divided into two phases. In the first phase regulation of turning on the steps of chromosome replications and changes of chromosome condensation occur. In the second (so-called) distribution phase the sister chromosomes are distributed to sister nuclei. It is important to study the transition events resulting in transition from the replicative phase into the distributive phase.

In the future more research is necessary to know the relationship and coordination of the chromosome cycle and the spindle cycle. Progress is expected is the research of pole formation and orientation of poles. Finally, perspectives of problems of mitosis are discussed.

The papers presented are supported by abundant literature and followed by wide-ranging discussions. The short abstracts of the presented poster demonstrations close the volume. The lectures and discussions of workshop are abundantly illustrated by figures of first-class quality.

This excellent publication of the SPRINGER-Verlag can be highly recommended to all interested in cell division, cell cycle differentiation, morphogenesis, ultrastructure of cells, problems of microtubules, cancer and also in cell physiology as well as cytogenetics.

E. I. KOVÁCS

H. E. FISCHER: Heterosis. Vol. 9 of the series "Genetik, Grundlage, Ergebnisse und Probleme in Einzeldarstellungen". FISCHER Verlag, Jena 1978, 163 pp. 22 illustrations

After short historical survey, the theoretical and practical implications of heterosis are discussed and summarized in eight chapters, by both a classical and molecular genetical approach. The earlier, classical conceptions on heterosis, as well as the occuring notions and definitions are summarized in the various chapters, where partly the terminology is analysed historically, but the notions clarified on the basis of the examples and analyses which are presented also promote the interpretation of the chapters in succession. Forms at a gene level which play a part in the heterosis occuring in the interrelationship of geno- and plasma types, the role of the surroundings in the development of heterosis, molecular genetical implications,

and a few examples and possibilities of the applications in practice of heterosis are contained in the various chapters.

The earlier conceptions explaining the phenomenon of heterosis are arranged, in two groups. The hypotheses based on heterozygosis and called "superdominance" are classified into one of the groups, and the genetical and biochemical background of super-dominance is also described in detail with respect to the regulation of enzyme syntheses. The hypothesis called "dominance" belongs in the other group where heterosis is explained by means of the additive effect of the dominant genes. On the basis of these conceptions, the continuation of heterosis effect in the F_2 generation can also be explained. Both interpretations are such questions that recur in the chapter dealing with molecular-genetical aspects.

In examining the phenomenon of heterosis, gene-interactions can be taken into consideration from several viewpoints. A given "harmonious" interaction, complementarity, and fitness are strongly modified by the change in the gene combinations.

The balance of enzyme levels, strongly influencing the physiological state, is linked with heterosis as a gene product. The summary contains a number of examples from plants. Special forms can come into existence, as e.g. homogametic heterosis in the case of *Oenothera*, where owing to the ring connection of the chromosomes the complete genome functions as a complex.

The differences in the heterosis effects among the reciprocal hybrids are indications of the harmony and of the presence of possible interactions among plasma type, genome and plasmon. In certain examples, this difference can be traced back to organellum types, e.g. mitochondrion in *Sorghum* species.

From the viewpoint of phenotypic influence, fitness, the environment influences heterosis acting as a criterium in the realization of actions at a gene level. Adaptive heterosis, the introduction and explanation of the notions of eu- and pseudoheterosis are contained in this sphere of topics and are dealt with by the author.

A separate chapter with a number of illustrations contains the theoretical considerations related to the utilization of heterosis for animal husbandry and plant breeding.

There are more than 300 items of references indicating the comprehensive elaboration of the topic; ample interpretations and examples at a classical and a molecular level are provided.

A. H. NAGY

N. W. TIMOFEEFF-RESSOVSKY—A. N. JABLOKOV—N. V. GLOTOV: Grundriss der Populationslehre. VEB FISCHER Verlag, Jena 1977, 266 pp (with 89 illustrations)

Volume 8 of the series "Genetik" edited by Prof. H. STUBBE, and published by VEB Gustav FISCHER Verlag (GDR), is a translation of the book entitled Očerk učeniya o populjacii (Moscow 1973).

Books with a similar title have been published in great number — particularly in English — in the past two decades. In 1973 even in the GDR a high-level book on population genetics was published (D. SPERLICH: Populationsgenetik, Stuttgart 1973), also by Gustav FISCHER Verlag. Considering this, the book of TIMOFEEFF-RESSOVSKY, JABLOKOV and GLOTOV is in many respect a step backwards, although in some other aspects it is also an advancement.

The book is divided into 5 larger chapters. The first one entitled Biosphere—Biogeocenosis—Biocenosis—Population approaches the Earth from the space and finally reaches the concept of population, the characteristics of which are outlined in Chapter Two entitled Population, Chapter Three (Population Genetics) gives elementary basic knowledge of the subject.

Chapter Four entitled Population-Phenetics, is rather unique, dealing with a subject, usually not even touched upon in other population biological books. Many of the expressions in this chapter — like phenofond and gene-fond — are hardly in use nowadays. The last chapter entitled Populations—Evolution—Systematics discusses the types and factors of speciation. Each chapter ends with "closing remarks" summarizing the preceding discussion.

What is most missing in the book is the endavour to give exact formulations. Population biology is one of the few biological disciplines where the rules can be expressed by simpler or more complex mathematical equations. Such biomathematical treatment of populations has long traditions; also in the authors' country. The authors do not follow this trend but they rather choose the much more lose verbal solution instead of the mathematical expression. In this way such essential basic knowledge is practically left out of consideration as for example the exponential and logistical growth equations of the populations, those of the various types of selection and of the random processes, the most fundamental formulations of the interrelationships in populations, as for example the LOTKA—VOLTERRA-type equations, etc.

It is at the same time a positive feature of the book that there are field observations in great number, which are illustrative examples of the population dynamics from various aspects.

Most of the illustrations in the book are taken from TIMOFEEFF-RESSOVSKY's earlier publications and, given in collection, they represent a remarkable value of the book, particularly for us, because they are mainly European examples.

The book of TIMOFEEFF-RESSOVSKY, JABLOKOV and GLOTOV can be recommended to two types of readers, first to those who would like to know something of population biology but could be frightened away from this even by a simple exponential equation describing the population growth; and second, to readers who are specialists of population biology but who could use the book as a supplementary illustrative collection of examples.

G. VIDA

BEWLEY, J. D. and BLACK, M.: Physiology and biochemistry of seeds in relation to germination. I. Development, germination and growth, 1978. SPRINGER-Verlag, Berlin, Heidelberg, New York; 306 pp., 122 figures

The authors' aim is to consider "the biochemical and physiological phenomena that occur in a germinating seed and the activities that are unique to germination such as food mobilization and early growth of the seedling". First the book acquaints with the structure of the seed, with the physiological and biochemical processes taking place during the seed maturation and later deals with the same events proceeding in the germinating seed. The book consists of seven chapters each one having several sections. At the end of each chapter is an abundant reference list. Both English and botanical names of plants are used and a glossary and an index of them can be found as well. Moreover there is an author and subject index. The book is well illustrated with drawings, electron micrographs, biochemical pathways.

The first chapter deals with the seed, germination in general, the measure of germination (commonly used number of germinated seeds after a certain time), and the various methods used for calculating the mean germination rate of a population.

The second chapter is rather a basic one for the better understanding of the subsequent chapters. Here the seed structure of species of different plant families, the food reserves of seeds (protein, lectins, phytin, carbohydrates, etc.), their accumulation and location because they are closely associated with the structure are discussed. The reserve composition of seeds is reviewed in detail. The authors refer to its modifying factors, such as genetic factors, breeding, environmental conditions.

The third chapter concentrates on the studies of seed maturation. The developmental processes in the Gymnosperms and the Angiosperms, are reviewed briefly a comprehensive study on the production and storage of reserves in the seeds is given both in cereals and in dicots. The authors describe the physiological and the biochemical processes taking place during the synthesis of different storaged reserves, the differences in the synthesis among the cereals, endospermic and non-endospermic legumes. The other sections of this chapter contain the energy supply in the maturing seed, the fate of the synthesizing apparatus, hormones and their role in the developing seed.

The following two chapters (4, 5) are concerned with the imbibition, germination of seed, and growth of seedlings as well as the biochemistry of these processes. Chapter 4 treats the role of water including the water uptake by seeds, kinetics of this process and the various factors affecting the germination, such as soil moisture tension, the size and mucilage content of seeds, the nature of seed surface, etc.

The authors discuss the biochemistry of germination and growth in three sections of chapter 5, which are respiration, the protein and nucleic acid synthesis as well as the DNA synthesis.

In chapter 6 the processes taking place after radicle emergence in the germinated seed are discussed. The mobilization of different types of stored reserves (carbohydrates, lipid, protein and phosphorus — containing compounds), their metabolisms and hydrolysis both in cereals and in dicots are reviewed and presented with graphs, electron micrographs.

The last chapter concerns the control processes in the mobilization of stored reserves. It "involves a consideration of the effects of plant hormones on cell metabolism and, more specifically, of their actions in non-growing storage tissue". The cereal grain has proved to be most suitable object for studying these processes.

The book summarizes the comprehensive modern knowledge on the physiology and biochemistry of seeds in relation to germination, so it will be very useful for advanced students and research workers.

E. MOLNÁR

G. FARKAS: Növényi biokémia (Plant Biochemistry). Akadémiai Kiadó, 1978, pp. 405.

Gábor FARKAS's work entitled Növényi biokémia contains a maximum amount of knowledge available in this branch of science in a minimal sized volume. It comprises nine chapters discussing the most important results. At the same time, a number of such unresolved problems are treated arising from the special character of higher plants.

Chapter One provides information on the material that has accumulated so far in photosynthesis, with emphasis on the characteristics and differences occurring in paths of C_3 and C_4 dicarbonic acids, which play an important part in plant productivity, thus, on light respiration and on the varying possibilities of the effectiveness of photosynthesis. Chapter Two deals with the biochemistry of plant respiration, and, in addition, with some special plant physiological aspects of metabolism in respiration, as for example shoot respiration, climacterical respiration, salt respiration, parasitogenic respiration and that in the area of a wound, etc. Little have been known on plant lipid metabolism and the function of cell membranes at present, but these have recently gained importance. The interim results obtained are summarized in Chapter Three. The problems of nitrogen and autotrophy are discussed in Chapter Four. Here special care is taken to provide a critical analysis and synthesis of the results of new and old observations made in the field of nitrogen bonding.

In the past decade, in the field of plant biochemistry, our knowledge of the course of the synthesis of nucleic acid and protein has probably achieved the greatest development. The rapidly changing, often contradictory theories are summarized in a clear-cut manner in Chapters Seven and Eight. The special problems of the synthesis of nucleic acid and protein in higher plants, with regard to cell division, growth, development and aging, are discussed at the end of Chapter Eight.

Chapters Five, Six and Nine deal in short with the metabolism of amino-acids, nucleotides and of secondary metabolism products. Regrettably, the author does not provide any results in relation to bioregulators, stimulating and inhibiting materials; it would have been useful for specialists either interested in the theory or working in the field of applied plant physiology.

The book is pleasant reading owing to its good style and way of editing; after furnishing the most essential statements, the author also summarizes the experimental data which confirm the validity of the statements.

The author provides the reader with basic knowledge in simple sentences. Therefore, the book can be recommended to those who wish to know the "way of plant biochemical thinking", the characteristics of raising the problems, and the traps occurring in the study of the metabolism of higher plants.

The shortcomings that appear in acquiring knowledge on a larger scale are often characteristic of researchers absorbed in their own field of investigation. The reading of this book is to be recommended to those also who wish to be well-informed in the recent results of plant biochemistry on a larger scale, in addition to their special field. I should especially recommend this book as a basis for studies to those university lecturers whose task is to train the biologists, agrarian engineers of the future and the specialists dealing with environmental problems. Last but not least, the knowledge of this book is necessary for future plant physiologists since by means of this book they will be able to recognize the pleasant as well as the difficult sides of their vocation in their perspectives.

Thanks are due to the Akadémiai Kiadó for the publication of the book on a short-term schedule. We only hope that our specialized literature will be enriched with even more, similar "text-books" on a high level which will be of use for all of us.

M. DÉVAY

W. FREY, M. HURKA, F. OBERWINKLER. (eds): Beiträge zur Biologie der niederen Pflanzen. 1977. Stuttgart—New York, G. FISCHER Verl., 233 pp.

The book has been compiled and dedicated by the authors and the editors in honour of the 70th birthday of Prof. Dr. Karl MÄGDEFRAU. The articles, dealing with the taxonomical, phylogenetical and ecological problems of cryptogamous plants are new in their results, interesting, and use modern methods.

W. JUNG's study (Die ersten Landpflanzen) on the first terrestrial plants, summarizing the research results obtained so far, deals with the phylogenetical importance of *Psilophyta;* the still existing problems are not neglected and the necessity of further research is emphasized. Finally, the conditions of plant life in terrestrial plants are analysed.

M. Hurka's article (Isoensyme und Systematik), and that of A. Bresinsky (Chemotaxonomie der Pilze) deal with plant biochemistry. Isoenzymes today play an important part in evolution physiology. Their examination may open important vistas on the vital questions of evolution and taxonomy. For example, with regard to the role of gene drift within natural populations and among them; the effect of fertilization system on the structure of a kinship circle; or to the processes of species formation, etc.

The importance of the recognition of the metabolism products of fungi and of their toxic materials in taxonomical evaluations has been known since long. Accurate chemical analysis, grouping, and modern methodical determination of these specific fungi compounds as well as the exploration of their chemotaxonomic importance (the phylogeny of fungi, separation of related species, etc.) are the result of the recent decades.

E. Müller deals with the phylogeny of *Ascomyceta* (Systemfragen bei Ascomyceten); while the study of F. Oberwinkler with the new system of *Basidiomyceta* (Das neue System der Basidiomyceten).

M. Schuster writes about the evolution of *Hepaticae* and *Anthocerothae* (The Evolution and Early Diversification of the *Hepaticae* and *Anthocerotae*), stating that both form a monophyletic group.

W. Frey informs us about the new position on the phylogenetical history and groups of relatives of mosses in his article entitled "Neue Vorstellungen über die Verwandtschaftsgruppen und die Stammesgeschichte der Laubmoose". His examinations were extended to fossil specimens (*Muscites plumosus*, *M. fontinaloides*, etc.); to the structure of tissue. The author established the phylogenetical connection between the great groups of relatives of mosses.

There two remarkable studies in the volume on lichens, by J. Poelt—E. Romauch: Die Lagerstrukturen placodialer Küsten- und Inlandsflechten. Ein Beitrag zur ökologischen Anatomie der Flechten; and by S. Winkler: Flechten und Moose als Bioindikatoren.

Poelt—Romauch, by examining the habitat structure of coastal and terrestrial lichens, stated that the changes in the habitat structure of coastal lichen can be explained by ecological effects. These species live in habitats extremely exposed to lasting strong winds, salty seawater, and related mechanical effects (sand grains, icecrystals, etc.). The hyphae of the coastal crustose lichens are strongly attached to one another, the algal layer is divided into knots by the hypha bundles, while the medulla is densely filled with hyphae which are intertwined. The species pairs which were examined are as follows: *Caloplaca granulosa*—*Cal. verruculifera; Cal. saxicola*—*Cal. scopularis; Xanthoria elegans*—*X. resendei; Candelariella medians*—*C. arctica; Lecanora reuteri*—*L. straminea; Rinodina nombosa*—*R. balanina.*

A survey of the investigations and results achieved so far is given by I. Windler. It is expected from bioindicators that they should indicate the harmful materials early and in relatively small amounts. Lichens and mosses are plants that react very sensitively to harmful materials. After surveying the town of Tübingen, and establishing the "lichen desert" and the "struggling zone", he elaborated and applied a very demonstrative statistical method of quantitative analysis of lichen and moss vegetation. The extent of damage was examined in site examinations, partly morphologically and partly by photosynthesis measurement (gas metabolism).

K. Dobat: Zur Ökologie und Ökogenese der Lampenflore deutscher Schauhöhlen deals with the plant associations of 30 German caves, based on his own investigations and on the data of the literature. He determined the course of growth taken by the "lamp flora" from the algae to ferns, and examined the number of taxa occurring in relation to the number of light sources and to light intensity. Mosses and then algae occur in greatest quantity, while lichen only occasionally, in *Lepraria* stadium or in undeterminable forms. The author's conception on the passive migration of plant structures into the world of caves is very important.

P. K. Verseghy

B. F. Keegan, P. O. Céidigh and P. J. S. Boaden (eds): Biology of Benthic Organisms. Pergamon Press, Oxford, 1977. pp. XXXIII + 630.

This book contains sixty-three papers delivered the 11th European Symposium on Marine Biology, held at the University College, Galway (Ireland) from Oct. 5 till Oct. 11, 1976 in connection with the theme.

The papers are well illustrated with tables, graphs, maps, photographs and reference lists. The text is quite readable, although the typescripts of the authors have been reproduced in their original form. Eight of the papers are written in French, the others in English. Unfortunately, the volume has no subject index.

The themes of the papers are very widely with respect to the object of the studies, location of sampling (within Europa), the disciplines used (such as ecology, physiology, population dynamics, genetics, etc.).

Therefore, a detailed review of the whole volume is beyond the scope of this paper. So it seems to be better to list the major topics discussed in the papers. The sequence of the topics does not mean a rank of importance and they are not identical with the titles of the separate papers. The number of papers dealing with one or another topic is very different, that is several papers can belong to one topic, and vica versa. The purpose of this list is to give a relatively accurate picture of the contents of this book.

The following topics are found in the volume:

— structure, organization, development, succession of different macro- and meiobenthic communities on different types of substrate (e.g. rock, sand, mud, etc.) in different zones (littoral, bathyal, etc.)
— benthic community structure in relation to substrate, physical, oceanographical and biological parameters
— horizontal and vertical distribution and/or microdistribution of different groups (*Oligochaeta*, *Polychaeta*, *Copepoda*, bathyal *Decapoda*, benthic vegetation); distribution of benthic phyto- and zoocoenoses along light gradient in a superficial marine cave; the importance of biological interactions in the zonation of deep-sea gastropods
— composition, changes in composition through space and time of various groups (e.g. *Polycheate*, *Echinodermata*, *Nematoda*, periphytal *Copepoda*) and/or communities (e.g. different sublittoral communities, meiobenthic *Gastrotricha* subcommunities, etc.)
— relative abundance of macrobenthic species and fishes
— colonization of different substrates by molluscs
— the role of environmental factors in the dispersion of different genotypes of *Mytilus edulis*
— the problem of re-establishment of species
— the role of environmental factors on stability and distribution of rocky shore communities
— the contribution of littoral organisms to the zooplankton of inshore waters
— composition, density, biomass and vertical extension of benthic vegetation
— primary production and biomass of sublittoral muddy sands, *Fucus vesiculosus* and *Laminaria hyperborea*
— soft-bottom macrofauna production
— direct uptake of dissolved nutrients by soft bodied benthic invertebrates
— studies on suspension and deposit feeding communities
— predator-prey interactions; predation press and community structure
— energy transfer from marine macrophytes to consumers
— anaerob N-fixation in sediment
— reproductive strategies of different species (*Littorina rudis*, *Alcyonium hibernicum* and *Alcyonium digitatum*)
— autecological studies of several species (*Sargassum muticum*, *Modiolus modiolus*, *Siboglinum fiordicum*, and different epifaunal algae)
— epibenthic assemblages and the indication of environmental conditions
— niche studies of several littoral fishes
— the efficiency of benthic sampling methods.

As we can see the variety of the themes is large enough, and most papers have an ecological approach. The volume gives a cross-section of the recent problems having emerged during the study of marine benthic organisms. So it is very useful for everybody interested in this field, but a specialist can make use of it, too.

J. N. NOSEK

R. H. WHITTAKER and S. A. LEVIN (eds.): Niche. Theory and Application. Benchmark Papers in Ecology/3. DOWDEN, HUTCHINSON and ROSS, Inc., 1975, pp. 448.

The volume, selected edited and commented by R. H. WHITTAKER and S. A. LEVIN, is a vitally important part of the series entitled Benchmark Papers in Ecology. The book consists of 41 selected papers, divided into 7 Parts each provided with Editors' Comments.

The merit of the volume is twofold: the selected papers provide us with many studies which are not readily available today or at all, and the Editors' Comments (especially those on Parts II, III and IV) are in themselves to be considered as valuable, independent studies.

The four articles selected for Part I, lead as back to the roots of the niche concept; to GRINNELLS rather more faunistic and ELTONS more functional, but by all means qualitative conception. In Part II, the most essential extracts from the works of the classics of com-

petitive exclusion (VOLTERRA, GAUSE) are presented, while in the Editors' Comments certain corrections are to be found which call attention to the importance of genetical feedback — in addition to that of competition — and again to the significance of interaction between age classes, or to that of predation, as these are essential factors in the regulation of populations.

The species respond differently to the factors which arise in the community in space and time, and the response given to these spatio-temporal differences will be decisive with respect to the species' coexistence. Part III deals with niche axes, while the editors' Comments with such questions that determine the nature of the variables within the community. It is expounded in the Comments that in the community the most compact set of niche axes is given by the minimum independent series of limiting factors. Such zoologically important examples are dealt with as the competition along canopy height, the competition along with the nutrient volume axis, predation and parasitism. Seasonal changes frequently involve parameter changes taking place on a time scale; this gradient within the community is to be considered often as niche axis. Part of the examples is again ornithological; but ample examples could have been taken from the rich flowering-fruiting pattern of tropical forests (such citations would have been even more interesting because they can provide at the same time nice examples of the co-evolution of plants and animals). In this Part, the selection provides space for a few works dealing with population structure (genetical structure, age composition, dispersion, sex-ratio, etc.). Spatial aspects will be interesting for botanists: in uniform environments, coexistence can become possible as a result of random colonization and the diversification following that. Temporal changes ensuing in the genetical structure may even permit complete competitors to coexist, thus, also a genetical variable can be a niche axis (for example, interspecific frequency dependent selection). Two botanical works are presented in Part III; short extract of WHITTAKER entitled "Niche space and species importance" from his book "Communities and ecosystems", and HUTCHINSON's famous study entitled "The paradox of the plankton" (1961).

Part IV deals with habitat and niche dimensions. The separation of habitat and niche (cf. the important article of WHITTAKER—LEVIN—ROOT 1973, at the end of the collection) is consistent also in the book; the concept of habitat intercommunity, and of niche intracommunity; the ecological evolution takes the direction of habitat differentiation. A number of indices are suggested for the description of the habitat, as is contained in the Editors' Comments.

The niche axes, as against the habitat axes, are rather more defined biologically (for example, the fine features in the habits of prey and predator; the chemical characters of the plant which may protect against consumers). For the description of the niche, the following data are important; form of the distribution of the population, niche width, niche overlap, niche pattern on an axis, niche form. In the Editors' Comments also the competition coefficient α_{ij} (as an index of the overlap), and the LEVINS—VANDERMEER-type community matrix are dealt with in detail. It is also in this Part that the sample of articles is appropriately representative.

Part V deals with spatial and temporal contexts of the niche. Species looking for habitat in new areas may disappear for example if there is no niche available for them, while others (for example newly-introduced weeds may take the form of population explosion, having no enemies in their way. The spatial examples are rather zoology-centred, similarly as in Part VI, where the case studies of species coexistence patterns are dealt with, beginning with the experimental examination of the community structure and continuing with the site investigations of natural populations. Part VII bears the title Conclusion; three summarizing works are placed here, viz., HUTCHINSON's famous Concluding Remarks; MACARTHUR's The Theory of the Niche (the grain concept included), and finally the editors' study written in cooperation with ROOT, and often cited in the present volume: Niche, Habitat and Ecotope.

The book is warmly recommended to every ecologist, and especially to "general ecologists".

G. FEKETE

K. KREEB: Methoden der Pflanzenökologie. 1977. 235 pp, 69 figures. VEB G. FISCHER, Jena 41 Marks (Cloth)

The book is the result of a 17-membered research team's work carried out under the guidance of one of the students of H. WALTER, professor of plant ecology in the university of Bremen. It contains concisely instructively and in a clear-cut manner the methods, instruments their advantages and disadvantages, as well as questions of principle of plant ecology (primarily of autecology); the evaluation and the description of the procedure of mathematical

calculations are also given. Thus, the work is a methodological handbook, which is entirely up-to-date. The main chapters deal with the reaction of plants to environmental factors, thus with the different parts played by temperature, water, light and further chemical and physical factors in plant life, and also with the methods of their determination, within this with different resistances, with the phenomena of water metabolism, with photosynthesis, respiration, etc. thus, with the questions of physioecology. There is only little space devoted to problems with geobotanical implications, although phenology and biomass and even the mapping of indicator plants and associations play a part in the book. Thus, it is rather a methodical testbook written for ecophysiologists, and a continuation of the author's earlier main book (Ökophysiologie der Pflanzen, Jena, 1974). The application of certain latest field instruments, mainly electrical ones, will be learnt by geobotanists from this book. I should also emphasize the extremely ample bibliography (650 items), and a Hungarian author, B. Jámbor. The price of the book is very favourable.

R. Soó

Oberdorfer, E.: Süddeutsche Pflanzengesellschaften. 2nd ed. — I. 1977, 312 pp., 75 tables. VEB G. Fischer, Jena, 35 Marks

Oberdorfer's examplary elaboration of the plant associations of South-Germany was first published in the regional series of monographs entitled Pflanzensoziologie, in 1957, on 564 pp, covering the greatest area so far, in the spirit of the Zurich-Montpellier school. It has had a significant influence on the vegetation research of whole Central-Europe, thus on Hungarian authors as well. The book was still written by the author on his own, while the new edition designed for 4 volumes is already the work of a greater work-team. The co-workers of the first part published not long ago were Dierssen, S. Görs, Krause, Lang, Müller, Philippi, Seibert, that is, a number, partly young, members of the West-German school. Still, the work, in terms of its approach and construction, is entirely homogeneous, written under the guidance of Oberdorfer. The description of the various associations is concise, but it goes down as far as the subassociations; the tables are mostly the lists of major associations of individual groups (federation, Verband), with the percentage values of stability, although some new associations appear here for the first time. The classes elaborated are as follows: rock swards (*Asplenietea rupestris*, *Parietarietea judaicae*), wall-weed associations (*Thlaspietea rotundifolii*), water vegetation (*Lemnetea*, *Charetea fragilis*, *Potamogetonetea*), marsh and mud association (*Phragmitetea*, *Isoeto-Nanojuncetea*, *Littorelletea*, *Utricularietea*) marshland associations, those of spring moors (*Montio-Cardaminetea*), snow soil associations (*Salicetea herbaceae*) — their place is strange here — plain and transitory moorland associations (*Scheuchzerio-Caricetea fuscae*), peat-bog associations (*Oxycocco-Sphagnetea*). Some classes do not occur with us, while the classification of some others (for example, the drawing of plain moorlands, that is *Tofieldetalia*, into the class of *Caricetea fuscae*) cannot be agreed upon; neither can the designation of the author's names of some of the associations. From the Hungarian literature the most important ones have not been considered. Even so, the work is one of the most significant products of describing plant cenology, of a rising tendency even today, both in the West and in the neighbouring countries of Hungary, and of a declining tendency only in our country. The lay-out of the book is good — no pictures are included — and its price on the German bookmarket is very low, indicating that it is a GDR publication. Volume 2 is planned for 1978.

R. Soó

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НОВЫЕ НАЗВАНИЯ И НОВЫЕ ВИДЫ КУБИНСКОЙ ФЛОРЫ, ВЕРНЕЕ ФЛОРЫ АНТИЛЛ

А. БОРХИДИ и З. КЕРЕСТИ

В статье дается спосок номенклатурных изменений кубинской флоры, некоторые новые комбинации, новый ключ к определению растений кубинских видов рода *Ternstroemia* (*Theaceae*) а также в статье даны критические замечания в связи с таксономией актильского семейства *Gesneriaceae*. Далее в статье описывается типичные экземпляры кубинских видов *Harpalyce* (*Fabaceae*), *Amyris* (*Rutaceae*) и *Xylosma* (*Flacourtiaceae*),

А также дана критическая ревизия *Guapira rufescens* (Griseb.) Lundell (*Nyctaginaceae*) вместе с описанием двух новых видов.

ПРИМЕЧАНИЯ К НЕКОТОРЫМ КРИТИЧЕСКИМ И НОВЫМ ТАКСОНАМ КУБИНСКОЙ ФЛОРЫ

А. БОРХИДИ и О. МУНИЗ

Авторы пытаются разрешить некоторые таксономические проблемы кубинской флоры, предлагая несколько новых комбинаций и коррекций, а также дают описание новых для науки 10 видов, 1 гибрида и 3 вариантов. Они обсуждают проблемы *Magnolia leonis* Tujan. ex. Bisse и *Magnolia cacuminicola* Bisse (*Magnoliaceae*), вопросы разделения *Cissampelos reticulata* sp. n. от *Cissampelos Pareira* L. (*Menispermaceae*), и межвидовые различия *Pera longipes* Britt. et Wils., *P. pallidifolia* Britt. et Wils., *P. ovalifolia* Urb. и *P. orientensis* sp. n. (*Euphorbiaceae*). Авторы занимаются таксономической проблемой *Purdiaea nipensis* M. Vict. и *P. maestrensis* Borhidi et Catasus и дают новый ключ для определения 8 кубинских видов рода *Linociera* (*Oleaceae*) и описание новых видов рода *Linociera* (*L. acunae* и *L. moncadae* sp. n.). Дальные новые таксоны: *Xylopia acunae* Borhidi et Del-Risco (*Menispermaceae*), *Pera polylepsis* ssp. *moaensis* Borhidi (*Euphorbiaceae*), *Ilex baracoensis* Borhidi и *I. hypaneura* var. *nudicalyx* Borhidi (*Aquifoliaceae*), *Ouratea x acunae* Borhidi (*Ochnaceae*), *Linociera bumelioides* ssp. *obovalis* Borhidi et Muñiz (*Oleaceae*), *Forestiera ekmanii* Borhidi (*Oleaceae*), *Lantanopsis tomentosa* Borhidi et Moncada (*Compositae*).

ЦИТОХИМИЧЕСКОЕ ИЗУЧЕНИЕ ТОЧКИ РОСТА СТЕБЛЯ ЯБЛОКИ I.

Содержание ДНК и ДНК + РНК и гистона в ядрах клеток верхушечных порек завязи, образующей плоды и не образующей плодов

Т. БУБАН и Г. И. ХЕЗЕМАНН

В интересах использования химикатов, управляющих образованием цветочных почек, нам нужно знать отношения внутри верхушечной меристемы, на протяжении перехода из вегетативного состояния в репродуктивное. Авторы исследовали верхушечные почки (т. н. пик) завязи, из которых развиваются и не развиваются плоды. На срезах при помощи цитофотометрии измряли в различных зонах точки роста уровень ДНК и ДНК + РНК и гистона. При наличии плода уровень нуклеиновых кислот ниже а содержание нуклеогистона выше. Эти условия тормозят образование цветковой почки. Отсутствие плода имеет противоположный эффект и при положительных условиях обеспечивает образование цветов. Заслуживает особого внимания то, что бесплоные пиковые верхушечные почки в действительности можно считать индуцированными для перехода в репродуктивное состояние. Возможно, что основа индукции отсутствие эндогенных факторов управляющих ростом в зачатках семян молодых плодов (в основном гибберилин).

ХАРАКТЕРИСТИКИ NICHE ПОПУЛЯЦИЙ FESTUCA VAGINATA НА ОСНОВАНИИ РАСТИТЕЛЬНЫХ И ПОЧВЕННЫХ МАКРО- И МИКРОЭЛЕМЕНТОВ

Г. ФЕКЕТЕ, И. ПРЕЧЕНЬИ, А. ХОРАНСКИ, Д. ТЕЛЬДЕШИ

Авторы изучали с трех дернов с доминантностью (*Festuca vaginata*) индивидуумы *Festuca vaginata*, а также исследовали содержание в ночве макро- и микроэлементов с той целью, чтобы изучить, какие свойства почвы надо принимать во внимание при описании

niche. Исследуемые элементы: **K, Ca, P, Mg, Na, Al, Fe, Mn, Zn.** Для оценки использовали B_i формулу (разделенную числом категории) и анализ $Д^2$. На основе последнего получили некоторую оценку с какой эффициенсией растения используют питательные элементы, педназначенные для самих себя. Среди трех популяций одна из них происходит с эдафичного полупустынного места (Фюлепхаза), другая с среднегористой местности (Несмей), а третья из Вацратота, все три с песчанных почв. У образца взятого из Вацратота ширина **niche** высчитанная на основе растение/почва, на пяти осях **niche** самая большая. В образце взятом из Фюлерхаза широты сужаются, возможно по причине их специализации. Широта niche образцов взятых из Несмей уже, чем у образцов Вацратота из за компетиции растений-спутников. Использование питательного вещества тремя популяциями различно, на основании результатов, полученных анализом $Д^2$. На использование питательных веществ влияет активность и селективность растений.

ИССЛЕДОВАНИЕ ПЫЛЬЦЫ НЕКОТОРЫХ AMENTIFLORAE ПРИ ПОМОЩИ ЭЛЕКТРОННОГО МИКРОСКОПА СКАННИНГ

М. КЕДВЕШ

Автор начинает новую серию статей об изучении пыльцы некоторых таксонов *Amentiflorae* при помощи электронного микроскопа сканнинг. В этой статье автор занимается со следующими родами: *Corylus, Carpinus, Ostrya, Casuarina.*

ИЗУЧЕНИЕ ЦВЕТЕНИЯ И ГЕНЕРАТИВНОСТИ У ПОПУЛЯЦИЙ ADONIS VERNALIS L.

А. МАТЕ

Автор сделал следующие выводы на основе изучения процесса цветения и генеративности у индивидуумов растений *Adonis vernalis* L. Индексы V и G, которые выражают цветение и генеративность можно использовать и для характеристики популяций. В результате их использования можно определить возможность нахождения самого большого количества экземпляров растений в фенофазе полного цветения. Это фенофаза множественного цветения популяции. Значение индексов G, измеренных в стране расходится косо и это не совпадает с нормальным разхождением. В той же самой популяции у отдельных экземпляров растений значение индекса **G** расходится также косо направо. Исследование фенофазы цветения, как функции генеративности показало, что внутри популяции цветение растений с вамой большой генеративностью затягивается.

СОДЕРЖАНИЕ ЭЛЕМЕНТОВ В МЯГКОСТЕБЕЛЬНОЙ РАСТИТЕЛЬНОСТИ В ЛЕСУ QUERCUS CERRIS В ШИКФЕКУТ

И. МЕСАРОШ

Автор исследовал за вегетационный период 1974 и 1975 года содержание **N, P, K, Ca, Mg, Fe, Mn** и **Na** в мягкостебельных растениях произрастающих в Шикфекут в лесу *Quercus cerris.* На основании измерений, проведенных ежемесячно вычислили содержание элементов фитомассы мягкостебельных, разделение их по фракциям. Средние данные двухгодичных измерений показали, что максимальное содержание элементов фитомассы 17,07 кг/га, и более чем 50% накопляется в подземных частях. Во фракциях фитомассы элементы располагаются в следующем порядке:

надземные живые: $K > N > P > Ca > Mg > Fe > Mn > Na$

подземные вымершие: $N > K > Ca > Fe > P > Mg > Mn > Na$

подземные: $N > K > Ca > Fe > Mg > P \leq Mn > Na$

Сравнивая подразделение элементов по фракциям автор определил, что значение надземной живой фитомассы снижается по накоплению различных элементов в следующем порядке- **K, P, N, Na, Mg, Ca, Mn, Fe** что находится в противоречии с подземной фитомассой. Автор высчитал поглощение элементов мягкостебельной растительностью, отношение между фракциями однодневного накопления или потери питательного материала, а также отношение обмена элементами.

БРИОФИТИ ИЗ ШРИ ЛАНКА (ЦЕЙЛОН), III

М. ОНРЕДТ

Автор дает описание 2 новых видов для науки: ***Cololejeunea ceylanica* Onr.** и ***Cololejeunea hinidumae* Onr.** (***Hepaticae***), коллекционированных от автором в Шри Ланке (Цейлон).

НЕТТО ПРОДУКЦИЯ ДЕРЕВЬЕВ ДУБОВОГО ЛЕСА (QUERCETUM PETRAEAE-CERRIS) НА ПЛОЩАДИ ОПЫТНОГО УЧАСТКА В ШИКФЕКУТ (СЕВЕРНАЯ ВЕНГРИЯ)

Л. Б. ПАПП

В статье даются данные по нетто продукции деревьев дубового леса (***Quercus petraea, Quercus cerris***).

Годовая продукция нетто двух видов деревьев в лесу в сухом весе равна 10,784 т/га. Это количество содержит и количество листвы, съеденной гусеницами, которое в случае ***Quercus petraea*** приходится в среднем на гектар 1316, 2 кг, а в случае ***Q. cerris*** ежегодно равнялось 29,9 кг, каждый год между 1972 и 1975 годом (24,6%, 5,1%-съедание гусени[9] цами). Большая часть годовой продукции нетто древесного яруса 71,4% составляет продукция ***Quercus petraea*** 77,03 кг/га. Продукция ***Quercus cerris*** составляет 3080,8 кг/га (28,6%). Продукция древесного яруса 5,2 г/м²/день. Продукция листвы составляет 53,5%/5765,0 кг/га от общей продукции деревьев. Измеренное, не корригированное весом съеденной гусеницами количество опавшей листвы составляет 4418,9 кг/га, 84,2%-процента, 3722,8 кг/га попадает ежегодно на поверхность земли в форме опавшей листвы. 43,4, 45,1%-процент (4684,0 кг/га) дает годовой прирост веса деревьев, а 3,1% дают плоды и цветы. Годовая продукция опавшей листвы компонентов дерева (опавшие листья, погибшие деревья) составляют 1782 кг/га, вернее в древесных компонентах деревьев ежегодно накопляется 2902 кг/га органического вещества. Из проведенных исследований авторы определили, что большая часть ежегодной продукции нетто 5839,6 кг/га ежегодно попадает обратно на поверхность почвы, в противоположность с тем небольшим количеством вещества (2902 кг/га), который откладывается в древенистых частях. В годичный вес фитомассы авторы не зачислили это количество веса 696,1 которые перед опадением листвы частично попало обратно в девенистые части и частично на поверхность почвы.

АНАЛИЗ АССОЦИАЦИИ НА ОСНОВЕ ТЕОРИИ ИНФОРМАЦИИ

Я. ПОДАНИ

В статье авторы сообщают о новой разновидности анализа ассоциации. Параметры дивизии авторы опредлили на сонове теории информации, дивизным видом считают такой вид, у которого взаимная совокупность информации со всеми остальными видами максимальная. Полученный результат авторы сравнили с результатами, почуленными способом аггломераций, а также анализом главных компонентов. Автор предлагает анализ ассоциации использовать вместе с другими нумерическими способами.

РАСПОЛОЖЕНИЕ ВИДОВ В ТРЕХДИМЕНЗИОННОМ ПРОСТРАНСТВЕ NICHE

И. ПРЕЧЕНЬИ, Г. ФЭКЭТЭ, Е. МОЛНАР, Е. МЕЛКО, К. ВИРАГ

В статье обсуждается отношение между шириной **niche** и **overlap** девяти песчано-пустынно- дерновых видов, вместе в влажностью почвы и глубины корней включен доминантный вид ***Festuca vaginata*** как третья ось по покрытию. Самая большая ширина **niche** на третьей оси у ***Carex stenophylla***, а самая маленькая у ***Centaurea arenaria*** На этой оси оценка средних **overlap** одинакова, на этом основании их разделение едва различимо. Авторы также изучали расположение центра видов в трехдимензионном пространстве при помощи эквидного расстояния и анализа **cluster**. Два вида ***Medicago minima*** и ***Thymus* sp.** в каждой комбинации 3 осей образует **cluster**.

MANNIA TRIANDRA (SCOP.) GROLLE НОВЫЙ ЧЛЕН ВЕНГЕРСКОЙ ФЛОРЫ МХОВ

И. ШИЛЛЕР

В статье описывается новый альийский вид мха *Mannia triandra* (Scop.) Grolle найденный в горах Бюкк (Венгрия). Этот редкий экземпляр в венгерской флоре несомненно реликт из ледникового периода.

АНАЛИЗ РОСТА СВЕТОВЫХ И ТЕНЕВЫХ ЛИСТЬЕВ У QUERCUS CERRIS И QUERCUS PETRAEA

К. ВИРАГ

В статье автор занимается ростом площади и сухого веса у световых и теневых листьев двух видов дуба *Quercus cerris* и *Q. petraea.* Автор рассчитал характеристики роста RGR, NAR, LAR и RLGR для того, чтобы можно было проследить динамику продуктивности фотосинтеза. Полученные результаты дают объяснение о временном образовании площади листьев, которые неодинаково обеспечены освещением, о ритме накопления органического вещества, а также об изменении показателей роста. Автор изучал насколько выражено сходство и различие процессов роста с одной стороны- между световыми и теневыми листьями, а с другой стороны — между двумя видами дуба. Анализы роста автор проводил в 1973, 1974 и 1975 году. Площадь листьев и вес осенивались, как факториальный опыт. Автор определил, что площадь световых листьев всегда намного меньше, чем у теневых. Однако вес их несмотря на меньшую площадь, всегда больше. В них проходит процесс производства органических веществ более интенсивно. В световых листьях по сравнению с теневыми листьями RGR, выражающее ритм прибавления веса выше, а также выше и оценка отношения ассимиляции (NAR). В процессе роста листьев двух видов много сходства. Характеристики роста во времени в течении трех лет одинаковы. RGR NAR показывают изменение, соответствующее экспоненциальной показательной функции. У теневых листьев у двух видов едва имеется разница в интенсивности роста веса. Приблизительно одинаковы оценки RGR а также NAR. У световых листьев у *Quercus cerris* быстрее ритм накопления веса, оценки RGR и NAR выше, чем у *Quercus petraea.* У *Quercus cerris* содержание энергии у световых листьев всегда больше, чем у *Quercus petraea.*

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STUDY OF THE FIBER LENGTH FREQUENCY OF SOME CUBAN TREE SPECIES

By

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(Received 20. February, 1979)

In the present paper fiber length frequency of 15 Cuban wood species and shrubs was investigated. The studied species were as follows: *Curatella americana* L., *Calophyllum antillanum* Griseb., *Guazuma ulmifolia* Lam., *Luehea speciosa* Willd., *Alvaradoa amorphoides* Liebm. ssp. *psilophylla* (Urb.) Cronq., *Guarea guidonia* (L.) Sleumer, *Trichilia hirta* L., *Cyrilla racemiflora* L., *Cupania glabra* Sw., *Lysiloma bahamensis* Benth., *Myrsine cubana* A. DC., *Mastichodendron foetidissimum* (Jacq.) Cronq., *Linociera bumelioides* Griseb., *Cordia sebestena* L., *Quercus oleoides* C. et S. ssp. *sagraeana* (Nutt.) Borhidi. As comparison, two indigenous European species were investigated as well, namely: *Quercus cerris* L. var. *austriaca* (Willd.) Loud. and *Popolus alba* L.

Introduction

In 1976, M. VALES, head department of the Botanical Institute of the Academy of Sciences of Cuba, made a study trip of five months in Hungary with the scholarship of the Hungarian Academy of Sciences at the Anatomical Laboratory of the Research Institute for Wood Industry. He brought a collection of 23 wood samples from Cuba with the intention of study. During his stay in Hungary M. VALES elaborated the anatomical features of 4 species under the scientific attention of the author (BABOS and VALES 1977, VALES and BABOS 1977, VALES, BABOS and BORHIDI 1977). Returning to Cuba, he left the collection in the mentioned Institute, in exchange for Hungarian wood materials. In this paper, as an applied aspect of these xylotomic studies the fiber length frequency of 15 Cuban species from the mentioned collection is investigated (BABOS 1978).

In addition to the fiber length frequency the following features were measured and investigated: maximum fiber diameter, cell wall thickness, lumen and shape of the fiber ends. These features have been emphasized from the other anatomical characteristics because they have the greatest importance in view of a possible industrial applicability (e.g. fibreboard and chipboard industry, paper industry etc.).

It is to be noted that these tropical species and shrubs have not been yet examined from such respect, thus the present examinations are of pioneering character.

Materials

The studied species are chosen from the most various families, they mainly occure in the tropics and they were collected in different localities of Cuba. In order to compare, two European indigenous species were studied as well comparing the results of the fiber length measurements. Table 1 includes data relating to the localities of each species.

Table 1

Wood collections and herbarium vouchers

Species and Authority Family	Collectors and date	Diameters of the wood sample, cm	Place of collection	Location of herbarium vouchers
Curatella americana L. — *Dilleniaceae*	M. VALES and A. BORHIDI, Nov. 25. 1974	9.1	Pinar cerca de Mina de Matahambre Pinar del	Herbarium of the Academy of Sciences Cuba and collection in the Research Institute for Wood Industry Budapest
Calophyllum antillanum Griseb. — *Clusiaceae*	M. VALES, Nov. 20. 1974	12.5	Sierra del Rosario, Pinar del Rio	,,
Guazuma ulmifolia Lam. — *Sterculiaceae*	M. VALES, Oct. 9. 1974	10.5	Escaleras de Jaruco, La Habana	,,
Luehea speciosa Willd. — *Tiliaceae*	M. VALES and A. BORHIDI, Nov. 22. 1974	10.0	Camino al Mogote la Güira, Pinar del Rio	,,
Alvaradoa amorphoides Liebm. ssp. *psilophylla* (Urb.) Cronq. — *Simarubaceae*	M. VALES and A. BORHIDI, Dec. 15. 1974	4.5	Cabo San Antonio, 500 m del Faro Roncali, Pinar del Rio	,,
Guarea guidonia (L.) Sleumer — *Meliaceae*	M. VALES and A. BORHIDI, Nov. 19. 1974	7.3	Loma El Salón Sierra del Rosario, Pinar del Rio	,,
Trichilia hirta L. — *Meliaceae*	M. VALES, Oct. 29. 1974	8.5	Loma de Perle Jibacoa, La Habana	,,
Cyrilla racemiflora L. — *Cyrillaceae*	M. VALES and A. BORHIDI, Nov. 26. 1974	7.5	Loma Preluda Pinar del Rio	,,
Cupania glabra Sw. — *Sapindaceae*	M. VALES, Oct. 9. 1974	5.5	Escaleras de Jaruco, La Habana	Herbarium of the Academy of Sciences Cuba and collection in the Research Institute for Wood Industry Budapest
Lysiloma bahamensis Benth. — *Mimosaceae*	M. VALES, Feb. 20. 1975	8.0	Camino entre Playa Larga y Girón, Mantanzas	,,

Myrsine cubana A. DC. *Myrsinaceae*	M. Vales and A. Borhidi, Dec. 17. 1974	4.2	Entrada de la reserva de El Veral Guanahacabibes, Pinar del Rio	,,
Mastichodendron foetidissimum (Jacq.) Cronq. — *Sapotaceae*	M. Vales, May 8. 1975	6.8	Cerro Tuabaquey, Norte de Camagüey	,,
Linociera bumelioides Griseb. — *Oleaceae*	M. Vales and A. Borhidi, Dec. 14. 1974	8.5	El Veral Guanahacabibes, Pinar del Rio	,,
Cordia sebesteana L. — *Boraginaceae*	M. Vales and A. Borhidi, Dec. 15. 1974	7.8	Cabo San Antonio, a 500 m del Faro Roncali	,,
Quercus oleoides C. & S. ssp. *sagraeana* (Nutt.) Borhidi — *Fagaceae*	M. Vales and A. Borhidi, Nov. 23. 1974	9.0	Pinar sobre pizarra entre la Jagua Pinar del Rio	,,
Quercus cerris var. *austriaca* (Willd.) Loud. — *Fagaceae*	K. Babos and G. Hajdu, Sep. 15. 1972	20.0	Somogyaszaló, Deseda-völgy	Herbarium of the Research Institute for Wood Industry Budapest
Popolus alba L. — *Salicaceae*	K. Babos, May 14. 1977	45	Kerekegyháza	,,

Brief Morphological Description of the Studied Species

Curatella americana — shrub of height up to 6—8 m. *Calophyllum antillanum* — tree of height up to 30 m. *Guazuma ulmifolia* — tree of height up to 20 m. *Luehea speciosa* — tree of height up to 25—30 m. *Alvaradoa amorphoides* ssp. *psilophylla* — shrub or tree of height up to 15—20 m. *Trichilia hirta* — tree of height up to 25—30 m. *Guarea guidonia* — tree of height up to 30—35 m. *Cyrilla racemiflora* — shrub or tree of height up to 15—20 m. *Cupania glabra* — tree of height up to 30—35 m. *Lysiloma bahamensis* — tree of height up to 20—25 m. *Myrsine cubana* — endemic shrub or tree of height up to 10 m. *Mastichodendron foetidissimum* — tree of height up to 25—30 m. *Linociera bumelioides* — shrub or tree of height up to 10—15 m. *Cordia sebestena* — shrub or tree of height up to 8—12 m. *Quercus oleoides* ssp. *sagraeana* — tree of height up to 18—20 m (BABOS and BORHIDI 1978). *Quercus cerris* var. *austriaca* — tree of height up to 25—30 m. *Popolus alba* — tree of height up to 16—20 m (BABOS, FILLÓ and SOMKUTI 1979).

It is to be mentioned that the Cuban species having a tropical origin, do not form annual rings. However, the two home grown control species have a typical temperate origin, and they pronouncedly form annual rings.

Method of Examination

Blocks of 1×1 cm were made from the heartwood of the sample disks of the studied species. The blocks were cut into pieces along the fibre direction, then they were indulgently pulped with a SCHULZE macerating solution. The pulped materials were dyed with a 5 per cent diluted solution of Toluidin blue, and preparations were made. The measurements of the fiber lengths were carried out with a Zeiss microscope provided with a video projective screen, magnified 120-times, by means of a square grid. The measurements of the fiber diameter and lumens, and the examination of the fiber ends were made with a ZEISS microscope, an ocular micrometer, magnified 300-times.

The whole number of the measurements was 1500 (measurements of 100 fibers for the 15 species).

The measured data were converted into microns (μm) and brought together for each species, then frequency diagrams were drawn.

The data were evaluated with a mathematical-statistical method. Mathematical mean values ($\bar{X}$), the standard deviation of the mean values (S), the error deviation of the mean values ($S_{\bar{x}}$) and the coefficient of variation of the mean value ($S_{\bar{x}}\%$) were calculated (SVÁB 1967).

The listed mathematical features were calculated to evaluate only the data of fiber length. Only mathematical average values and minimum-maximum values are given for the wall thickness and cell cavity.

Results of the Examinations

Fiber length

The mean values of the fiber length measurements, as well the number of occurrence of each range and the frequency curves plotted from the obtained data for each species have given a good comparison.

The mean values and their standard deviations as well other statistical data are given in the Table 2.

Figures 1, 2, 3 and 4 illustrate the transformations of the distribution curves plotted for each species from the frequency data. Among the studied species only *Guazuma*, *Alvaradoa*, *Cyrilla*, *Myrsine*, *Cupania*, *Linociera*, *Popo-*
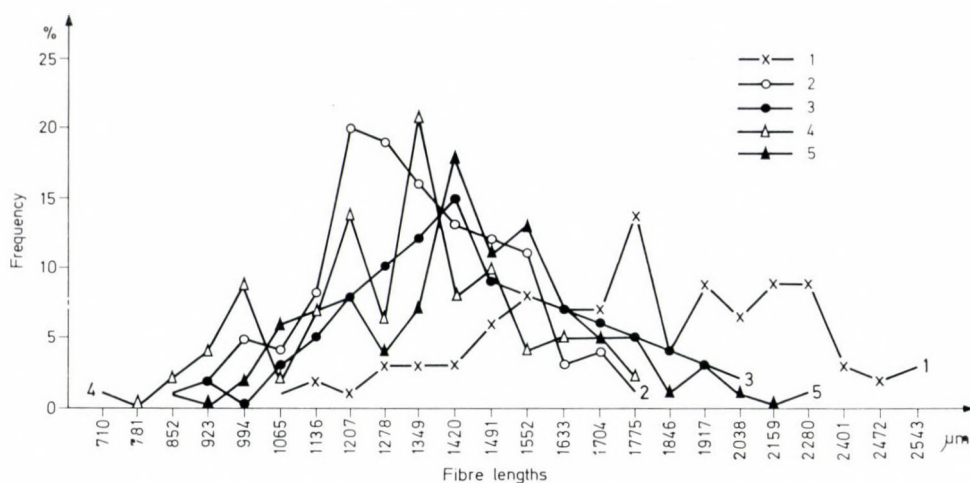
Fig. 1. Distribution of the fiber length frequencies in some Cuban tree species. — 1. *Curatella americana*, 2. *Calophyllum antillanum*, 3. *Guazuma ulmifolia*, 4. *Luehea speciosa*, 5. *Alvaradoa amorphoides* ssp. *psilophylla*
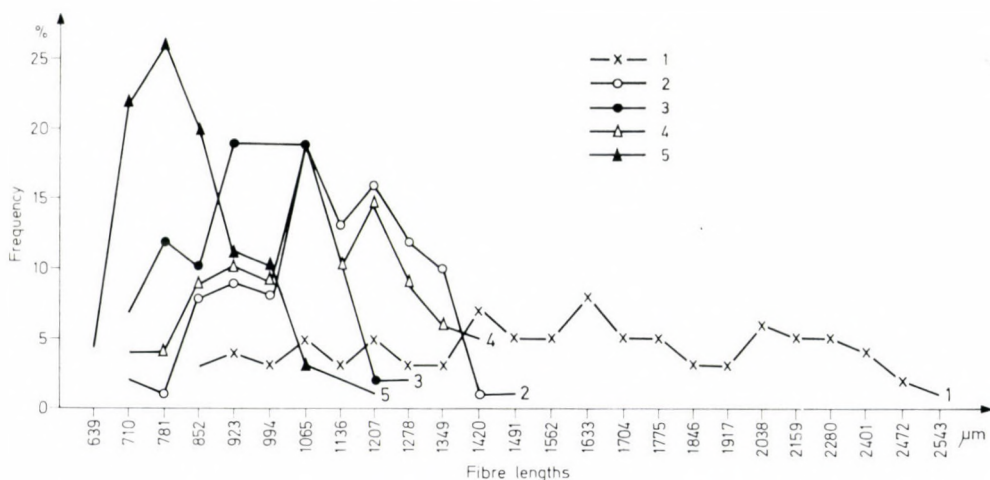
Fig. 2. Distribution of the fiber length frequencies in some Cuban tree species. — 1. *Guarea guidonia*, 2. *Trichilia hirta*, 3. *Cyrilla racemiflora*, 4. *Cupania glabra*, 5. *Lysiloma bahamensis*

lus were found to show a normal distribution or a form very similar to that (see Figs 1, 2, 3, 4).

A displacement of the distribution on the left was found in the *Lysiloma*, *Mastichodendron*, *Quercus oleoides* ssp. *sagreana* (see Fig. 2). A displacement of the distribution on the right-side was found in *Calophyllum*, *Trichilia*, *Linociera*, *Cordia* (see Figs 1 and 3). A plain distribution was found in *Curatella*, *Guarea*, *Quercus cerris* var. *austriaca* (see Figs 1, 2, 3).
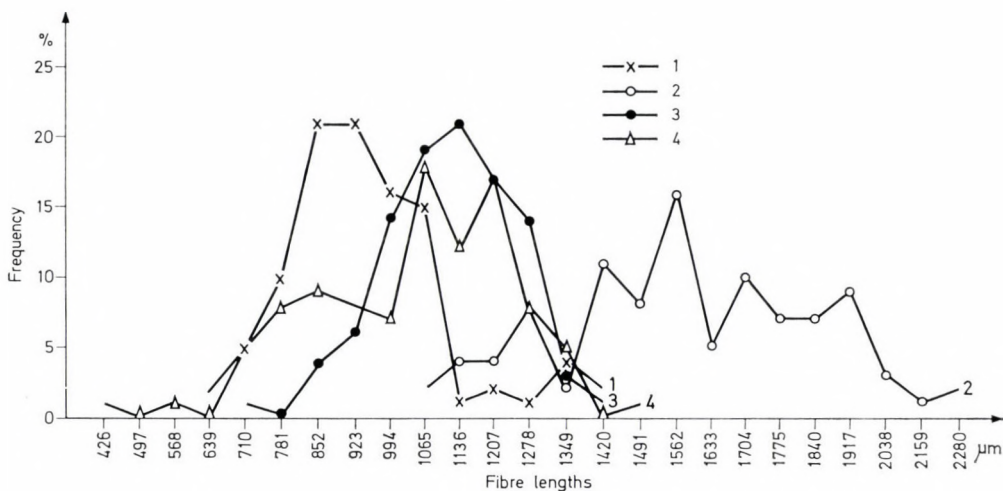
Fig. 3. Distribution pattern of the fiber length frequencies in some Cuban tree species. — 1. *Myrsine cubana*, 2. *Mastichodendron foetidissimum*, 3. *Linociera bumelioides*, 4. *Cordia sebestena*
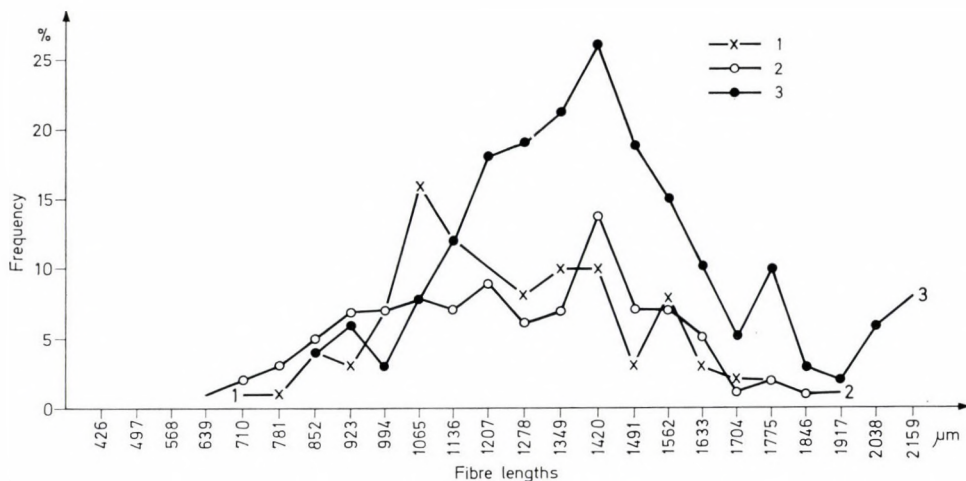
Fig. 4. Distribution pattern of the fiber length frequencies in Cuban and European tree species. 1. *Quercus oleoides* ssp. *sagraeana*, 2. *Quercus cerris* var. *austriaca*, 3. *Populus alba*

The average fiber length values of *Mastichodendron*, *Guarea*, *Alvaradoa*, *Luehea*, *Guazuma*, *Calophyllum*, *Curatella*, *Popolus alba* were greater than those of *Quercus cerris* var. *austriaca*. Lower fiber length values were found in *Cordia*, *Linociera*, *Myrsine*, *Lysiloma*, *Cupania*, *Cyrilla*, *Trichilia*. As an interesting fact was observed that in the two Quercus species belonging to selfsame family there are very similar fiber length values (*Quercus oleoides* ssp. *sagraeana*

Table 2

Mean values of the fiber measurements

Species	Family	$\bar{x}$ μm	±s μm	$s_{\bar{x}}$ μm	$s_{\bar{x}}$%
Curatella americana L.	*Dilleniaceae*	1792.75	283.07	199.74	11.14
Calophyllum antillanum Griseb.	*Clusiaceae*	1319.89	194.77	79.38	6.01
Guazuma ulmifolia Lam.	*Sterculiaceae*	1450.53	290.07	90.92	6.26
Luchea speciosa Willd.	*Tiliaceae*	1307.82	229.26	84.56	6.46
Alvaradoa amorphoides Liebm. ssp. *psilophylla* (Urb.) Cronq.	*Simarubaceae*	1442.01	242.33	249.31	17.28
Guarea guidonia (L.) Sleumer.	*Meliaceae*	1666.37	448.86	336.50	20.19
Trichilia hirta L.	*Meliaceae*	1113.28	166.08	73.89	6.63
Cyrilla racemiflora L.	*Cyrillaceae*	858.50	135.92	64.81	6.76
Cupania glabra Sw.	*Sapindaceae*	1082.04	183.35	71.00	6.56
Lysiloma bahamensis Benth.	*Mimosaceae*	829.28	120.19	64.81	7.81
Myrsine cubana A. DC.	*Myrsinaceae*	948.56	160.98	73.89	7.79
Mastichodendron foetidissimum (Jacq.) Cronq.	*Sapotaceae*	1592.53	260.47	310.02	19.46
Linociera bumelioides Griseb.	*Oleaceae*	1115.41	130.89	71.00	6.36
Cordia sebestena L.	*Boraginaceae*	1045.83	197.11	86.89	8.30
Quercus oleoides C. & S. ssp. *sagraeana* (Nutt.) Borhidi	*Fagaceae*	1241.08	242.86	84.41	6.8
Quercus cerris var. *austriaca* (Willd.) Loud.	*Fagaceae*	1249.60	281.65	144.90	11.59
Popolus alba L.	*Salicaceae*	1431.71	283.17	121.24	8.46

1241.08 μm, *Quercus cerris* var. *austriaca* 1249.60 μm). However, between the corresponding values of *Guarea* and *Trichilia* belonging to the same family (*Meliaceae*) as well, there is a significant difference (*Guarea guidonia* 1666.37 μm, *Trichilia hirta* 1113.28 μm). It is to be emphasised the high mean fiber length value of *Curatella americana* (1792.75 μm).

Wall Thickness and Lumen of the Fibers

Values of wall thickness and lumen of fibers and the transformations of the fiber ends are contained in Table 3.

According to data of the Table, *Mastichodendron* and *Guarea* have the largest wall thickness. *Luehea* has the most unchanging wall thickness. The largest lumen was found in *Curatella* and *Popolus alba*. The fiber ends have no significant differences. However, the bifurcating fiber ends (felting) are ad-

Table 3

Wall thickness and lumen measures of the fibers

Species	Wall Thickness μm Min. — Average — Max.	Lumen in μm Min. — Average — Max.	Fiber End
Curatella americana	3.4— 9.0 —12.6	6.9—15.4—25.3	Ending in a smooth peak or saw-toothed and bifurcating
Calophyllum antilanum	6.9— 7.8 —11.5	4.6— 7.6— 9.2	Ending in a smooth peak, rarely bifurcating
Guazuma ulmifolia	3.5— 6.4 — 9.2	— 2.3 —	Ending in a smooth peak, rarely sawtoothed
Luehea speciosa	— 2.3 —	3.5— 1.9— 9.2	Long ending in a peak, mildly saw-toothed, rarely bifurcating
Alvaradoa amorphoides ssp. *psilophylla*	2.3— 3.6 — 4.6	4.6— 9.0—14.9	Long ending in a peak, saw-toothed, rarely bifurcating
Guarea guidonia	9.2—12.8 —13.8	4.6— 9.3—13.8	Ending in a smooth peak
Trichilia hirta	6.9— 9.7 —11.5	2.3— 4.6— 6.9	Ending in a smooth peak, saw-toothed
Cyrilla racemiflora	6.9— 8.1 —11.0	2.3— 4.0— 4.6	Ending in a smooth peak, rarely saw-toothed
Cupania glabra	3.5— 6.3 — 9.2	4.6—11.2—16.1	Ending in a smooth peak
Lysiloma bahamensis	6.9— 8.6 — 9.2	4.6— 8.3—11.5	Ending in a smooth peak
Myrsine cubana	9.2—11.6 —14.2	6.9—14.9—20.7	Ending in a smooth peak
Mastichodendron foetidissimum	11.5—16.1 —20.7	— 2.3 —	Long ending in a peak or saw-toothed
Linociera bumelioides	4.6— 9.7 —13.8	2.3— 3.4— 4.6	Long ending in a peak, sometimes bifurcating and saw-toothed
Cordia sebestena	— 5.7 —	4.6— 5.8—13.8	Ending in a smooth peak, sometimes bifurcating
Quercus oleoides ssp. *sagraeana*	3.9— 5.1 — 6.9	— 2.3 —	Long ending in a peak, sometimes bifurcating
Quercus cerris var. *austriaca*	2.3— 5.3 — 8.5	2.3— 4.6— 6.9	Long ending in a peak, sometimes bifurcating
Popolus alba	2.3— 3.45— 4.6	4.6—13.8—25.3	Ending in a smooth peak, rarely bifurcating, saw-toothed

vantageous in respect of defibering. Such fiber ends were found in *Curatella* and *Mastichodendron*. Bifurcating fiber ends were rarely found in *Calophyllum*, *Luehea*, *Alvaradoa*, *Linociera*, *Cordia*, *Quercus oleoides*, *Q. cerris* var. *austriaca* and *Popolus alba*. At the industrial application of the wood fiber board the degree of felting is greatly influenced by two important factors besides the fiber end, namely the fiber length and wall thickness.

REFERENCES

Babos, K. (1978): Néhány trópusi fafaj rosthossz-gyakoriságának vizsgálata. (Study on fiber length frequency of some tropical woods). Közlemények a Faipari Kutatások Eredményeiről. Kézirat. Faipari Kutató Intézet, Bp. 203—213.

Babos, K.—Borhidi, A. (1978): Xylotomic study of some woody plant species from Cuba, I. — Acta Bot. Acad. Sci. Hung. **24,** 15—40.

Babos, K.—Borhidi, A. (1978): Xylotomic study of some woody plant species from Cuba, II. — Acta Bot. Acad. Sci. Hung. **24,** 235—262.

Babos, K.—Filló, Z.—Somkuti, E. (1979): Haszonfák (Timberwoods) Műszaki Könyvkiadó, Budapest.

Babos, K.—Vales, M. (1977): Négy kubai endemikus fafaj előzetes xylotómiai vizsgálata (Preliminary xylotomic study of four endemic species from Cuba) — Bot. Közlem. **63,** 179—182

Vales, M.—Babos, K. (1977): Wood anatomy of Ceratopyxis Hooker F. ex Hooker (Rubiaceae) a monotypic endemic genus of West Cuba. — Acta Bot. Acad. Sci. Hung. **23,** 275—283.

Vales, M.—Babos, K.—Borhidi, A. (1977): On the wood anatomy of Bombacopsis A. Robyns (Bombacaceae) and Magnolia cubensis Urb. ssp. cubensis (Magnoliaceae). — Acta Bot. Acad. Sci. Hung. **23,** 427—437.

Sváb, J. (1967): Biometriai módszerek a mezőgazdasági kutatásban. (Biometric methods in the agronomic researches.) — Mezőgazdasági Kiadó, Budapest.

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PHYTOPLANKTON COMMUNITY STRUCTURE STUDIES ON LAKE VELENCE, HUNGARY. — I. DIVERSITY

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Species composition and quantitative analyses of phytoplankton were carried out in three areas of different eutrophic level of Lake Velence; 242 taxa were determined, of which 118 data are new for the Lake. Diversity was calculated from the data using Shannon's formula.

On the basis of our methodological examinations for testing the phytoplankton diversity is suggested, the method of optimizing the total count of individuals (OPT).

It has been stated that the rare species do not considerably influence the diversity index.

In a decreasing sequence of the diversity index of the phytoplankton community collected, the three areas of Lake Velence were as follows: Fürdető, Nemfogi-tisztás, Gallér. Fürdető polluted by two creeks was the most favourable habitat for plankton algae in 1972. The reason is that the plant nutrients reaching the Lake still cause increasing tendency in diversity of the phytoplankton in Fürdető. In the next two years, the increase in the nutrient supply led to a substantial decrease in diversity. According to our hypothesis the diversity index increases with increasing eutrophication level in a certain domain, while after reaching the turning point it has a decreasing tendency.

Introduction

The diversity index of natural biocoenoses provides important information to hydrobiologists and the specialists in the field, on the structure and living conditions of the given community, therefore, throughout the world it is increasingly used. In the present study, species composition and quantitative analyses of phytoplankton were carried out in three areas of Lake Velence to calculate the species-individual diversity from the data obtained. At the same time, methodological examinations were also performed to determine the most suitable method for quantitative analyses of diversity and to clarify the role of rarely occurring species.

In the 1930s, Halász (1939, 1940) dealt with the detailed analysis of the algal flora in Lake Velence. Some other data were published by Daday (1897), Entz (1927, 1930), Gimesi (1936), and Schiefner (1964). Unger (1925) elaborated quantitative analyses. The work-team of VITUKI has been conducting investigations into the Lake since 1969. Algological results were published by Bartha (1977).

Materials and Methods

On the basis of earlier data (Bartha 1977) three research areas different in character were selected (Fig. 1). The samples taken from spring to autumn in 1972 were chosen for our examinations, since at that time these areas were still definitely separated from each other from the point of view of water quality.

In the reeds of the SW-part of the Lake is situated the reeds-clearing called Gallér, belonging to the characteristic examples of the so-called dark-brown water area. Its water is clear up to the bottom and its colour dark-brown (owing to the low content of suspended solids, the brown colour of humus is predominant). According to Felföldy's measurements the water is moderately alcaline (sodic), its conductivity is $2200 \cdot 10^{-6}$ $ohm^{-1}cm^{-1}$ (average value, 1972). The physical parameters (average water depth, temperature) and the main ions–together with the corresponding data from the other two research areas are summarized in Tables 1 and 2. The quantity of phytoplankton in Gallér compared to the other sampling areas is small, 2—5 millions i. $lit.^{-1}$ (i = individual) (see Table 6).

The Nemfogi-tisztás belongs to the grey waters area consisting of large, continuous water-surfaces in the middle part of the Lake. Owing to motions and constant stirring, its water is turbid. The ion concentration is high, its conductivity is $2425 \cdot 10^{-6}$ $ohm^{-1}cm^{-1}$

Fig. 1. Sampling locations on the Lake Velence. — 1. Gallér, 2. Nemfogi-tisztás, 3. Fürdető

(average value, 1972). On the basis of its inorganic chemical properties the water has a character between moderately and solidly alkaline (sodic) water. The quantity of algae is at an average level (5—7 millions i. $lit.^{-1}$).

The third research area was Fürdető, which is located in the NE end of the Lake. It is a shallow area with a reedless shore polluted by his creeks. As a consequence of stirring up the high suspended solid content of inflowing streams and rich phytoplankton the water is very turbid. Its colour, especially in summer, is definitely green, this is why the area is called the green water area. The water is moderately alkalic its conductivity is $2034 \cdot 10^{-6}$ $ohm^{-1}cm^{-1}$ (average value, 1972), is very productive and strongly algal (32—98 millions i. $lit.^{-1}$).

The characterization of the water quality areas and the chemical data have been taken from FELFÖLDY's work (manuscript 1973 and 1976) (Table 2).

For the quantitative analyses 250 ml of water was taken from a point 30 cm below the surface, which was fixed at the site with lugol-solution and then treated with formalin. The counting from the aliquot parts of the samples was carried out by means of the Utermöhl reversed microscope.

Three methods of counting were applied to the methodological examinations. For practical purposes the methods were designated separately as follows.

(1) The method of counting up to a fixed total count (FIX); counting a fixed number of individuals (600 individuals) in each samples;

(2) "Algologists method" (ALG); counting the algal individuals on 3—5 diagonal lines by samples (algologists usually apply this method in their quantitative examinations);

(3) Optimization of the total count (OPT). In this case the data of each diagonal will be recorded separately and the diversity will be determined from the cumulatively increased samples. The counting will be continued until the increase of the diversity index slows down, its curve flattens and it satisfactorily approximates an asymptotical value characteristic for the sample. By drawing this curve one can see, when involving newer samples the curve, fluctuates and is like an incisor a saw-tooth.

Naturally, these fluctuations gradually slow down towards increasing N (where N is the number of actually counted algae) but they can be observed throughout. Two requirements must be co-ordinated optimally here: counting must by all means be continued till the

Table 1

Physical parameters and changes in dissolved O_2, 1972

Time of sampling	Gallér		Nemfogi-tisztás		Fürdető	
	Depth, cm	Secchi depth, cm	Depth, cm	Secchi depth, cm	Depth, cm	Secchi depth, cm
19. April	135	135	205	58	115	22
19. May	140	140	200	35	60	25
20. July	135	135	180	55	110	17
4. September	125	125	180	60	100	18
1. October	140	140	200	37	100	27

	Temperature of water, °C	Dissolved O_2, mg/l 10 cm below the free surface	Temperature of water, °C	Dissolved O_2, mg/l 10 cm below the free surface	Temperature of water, °C	Dissolved O_2, mg/l 10 cm below the free surface
19. April	14.5	10.0	14.8	10.0	15	10.5
19. May	17	9.9	17.5	9.7	20	13.8
20. July	25	8.5	26	10.3	25	10.4
4. September	21.5	9.6	20.8	8.6	21.5	10.2
1. October	13.5	10.4	13	10.2	12	11.8

flattening section of the curve is reached, but so farther, because the tiresome microscope work has to be minimized.

The total count of individuals (N) in a sample is the sum of counts in individuals by species (n_i). This can be the number of individuals counted under the microscope or a value referred to a litre volume, since SHANNON's formula used here does not register the differences in magnitude of the two data.

To explaine the role of rarely-occurring species also the whole base plate was examined in each case.

Table 2

The quantity of the main ions (October 1972), mg/lit.$^{-1}$

	Gallér	Nemfogi-tisztás	Fürdető
K	43	42	38
Na	239	250	214
Ca	19	16	21
Mg	148	170	146
CO_3	132	126	126
HCO_3	488	658	591
Cl	151	154	139
SO_4	300	309	244

In accordance with the procedure generally applied in hydrobiology the number of algal individuals was always counted that is the colonies, the filaments and coenobies which belonged together were taken as one individual. The result were re-calculated for one liter (i. liter^{-1} = individuals per liter).

Many indices for computing the diversity have been determined. Their presentation and comparison may be found in several works (WILHM 1967; ARCHIBALD 1972; DE BENEDICTIS 1973; STONEBURNER, SMOCK and EICHHORN 1976; NOSEK 1976; HAJDU 1977; LILLJELUND 1977). The good indices characterize the structure of the association taking into consideration the number of species and their relative frequency simultaneously (PIELOU 1975).

On the basis of earlier examination, the well-proved SHANNON's formula from the information theory was used, which takes into consideration the more frequent species to a larger extent, while it also registers the changes in the frequency or rarely-occuring organisms (PEET 1974). The index was calculated with a logarithm base to 2, from data on individual per species.

Results and Discussion

Species Composition

In the course of examining the species composition of the phytoplankton, 200 species of 78 genus, 29 varieties and 7 forms were determined. Among those 118 taxa are new to Lake Velence.

The data of species composition and quantitative analyses are summarized in Table 6 (the new taxa are marked by an asterisk).

The research areas Gallér and Fürdető are rich in taxa, while the Nemfogi-tisztás is poorer. The members of the *Chlorophyta* division are dominant in all the three areas. The *Chrysophyta* and *Cyanophyta* divisions are also represented in a considerable number. In the Gallér area the members of *Pyrrophyta*, while in the other two areas those of *Euglenophyta* occurred in greater number.

A large portion of taxa (94) occurred in all three sampling sites, but in Gallér and Fürdető the quantity of those occurring only in these areas was also considerable (in Gallér, 53; in Fürdető, 43 taxa). Regarding both the species composition and the number of individuals, the Nemfogi-tisztás represents a transition between Gallér and Fürdető. Of its 138 taxa, altogether 7 did not occur also in the other two sampling areas. The greater number of the representatives of *Desmideaceae* in Gallér is also worthy of mention (Table 3).

Methodological results

The aim of the methodological research was to clarify the following two problems:

(a) what calculation method is most suitable for determining the diversity index;

(b) to what extent do rarely occurring species influence the diversity values; whether it is worthwhile to count a larger area in the UTERMÖHL chamber for finding a few rarely-occurring species.

Table 3

Number of taxa found in the sampling locations

	Gallér		Nemfogi-tisztás		Fürdető	
Cyanophyta	27	(9)	20	(1)	27	(9)
Euglenophyta	9	(–)	17	(2)	22	(6)
Chrysophyta	38	(17)	26	(2)	31	(8)
Pyrrophyta	11	(1)	9	(–)	6	(1)
Chlorophyta	85	(26)	66	(2)	83	(19)
Total	170	(53)	138	(7)	169	(43)

(Numbers in brackets indicate the taxa occurring only in the given sampling area.)

To answer the first question, the results obtained by the three calculation strategies were compared. The data on diversity, evenness and count of species are given in Table 4.

Table 4

Diversity (H″), evenness (J″), and species number (s) data obtained from examination by different methods

Area	Month	Methods								
		FIX			ALG			OPT		
		H″	J″	s	H″	J″	s	H″	J″	s
Gallér	A	2.33	0.44	37	2.33	0.44	37	2.33	0.44	37
	M	1.97	0.35	46	1.99	0.32	71	1.99	0.32	71
	J	4.96	0.82	67	4.96	0.82	67	5.06	0.84	63
	S	4.36	0.73	62	4.26	0.71	64	4.36	0.73	62
	O	3.42	0.59	54	3.64	0.60	64	3.64	0.60	64
Nemfogi-tisztás	A	4.44	0.80	46	4.45	0.79	49	4.48	0.84	40
	M	3.79	0.67	48	3.92	0.66	62	3.92	0.66	62
	J	2.85	0.55	36	3.04	0.55	47	3.04	0.55	47
	S	3.51	0.63	46	3.49	0.60	56	3.51	0.63	46
	O	3.85	0.69	46	3.85	0.69	46	3.85	0.69	46
Fürdető	A	4.20	0.76	39	4.38	0.75	56	4.38	0.75	56
	M	4.45	0.74	62	4.44	0.70	81	4.45	0.74	62
	J	4.88	0.82	62	4.93	0.79	75	5.02	0.82	69
	S	4.21	0.72	57	4.39	0.70	75	4.39	0.70	75
	O	3.59	0.59	65	3.62	0.57	77	3.63	0.59	71

Table 5

Number of species (expressed in percentage of the total count) resulting in 50.95 and 100% of diversity index (H")

Research area	Month	Species giving 50% of H"		Species giving 95% of H"		Species giving 100% of H" (total count)	
		No.	%	No.	%	No.	%
	A	4	10.8	31	83.8	37	100
	M	8	11.3	51	71.8	71	100
Gallér	J	11	16.4	51	76.1	67	100
	S	10	15.6	46	41.9	64	100
	O	7	10.9	47	73.4	64	100
	A	9	18.4	37	75.5	49	100
	M	7	11.3	41	66.1	62	100
Nemfogi-tisztás	J	5	10.6	29	61.7	47	100
	S	5	8.9	37	66.1	56	100
	O	6	13.0	34	73.9	46	100
	A	10	17.8	39	69.6	56	100
	M	9	11.1	49	60.5	81	100
Fürdető	J	11	14.7	53	70.7	75	100
	S	9	12.0	46	61.3	75	100
	O	7	9.1	52	67.5	77	100

The most accurate method requiring also the least work in that of optimizing the total count (OPT). This is followed in accuracy by the so-called "algalogists" method (ALG), which is however much more laboursome. This method was used for counting up to the greatest number of individuals, therefore, the greatest number of species was found here, however the values of evenness were lower.

The less satisfactory is the method of counting up to a fixed number of individuals (FIX), which does not need too much work, but H_{FIX} differs to the greatest extent from H_{OPT}. This difference is still smaller than that occurring in the diversity of the various habitats, thus it would not influence the possible conclusions. However this is valid only for the samples examined here. In another lake the situation may be different.

For general usage the method OPT is suggested. This is to be carried out as follows. In counting the individuals the diversity has to be calculated first for smaller units (one visual field, one cm, or one diagonal line in the chamber; in case of non-quantitative samples, after counting about 100 individuals). A further unit has to be taken only if the fluctuation of the diversity has not yet decreased below a certain level, which is to be established on the basis of

experience. If a further unit is investigated (a visual field, cm, or diagonal), will be summed the data to those found in the preceding count (cumulatively increased total count). The new diversity is calculated then from the cumulative result. In this way, the exact result can be attained with the least work under the microscope, which is very important considering the extremely tiresome microscopic counting.
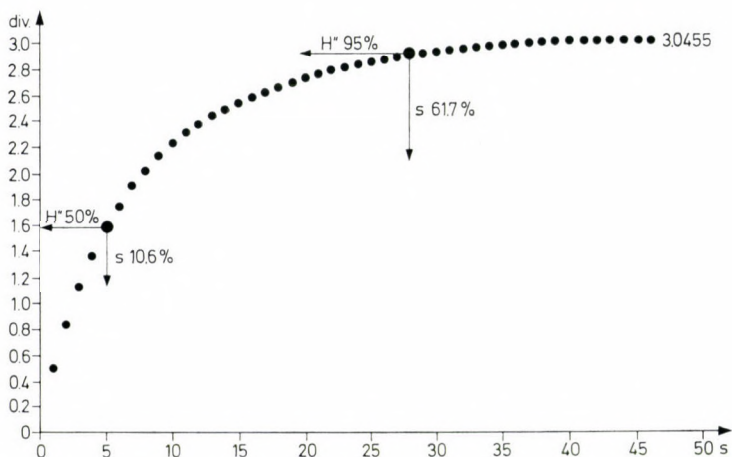
Fig. 2. Correlations between the count of species and diversity in an arbitrarily chosen sampling (July, Nemfogi-tisztás)

In samples where the evenness is small, the calculation of diversity must by all means be carried out by small units (for example, by visual fields), since it may happen that the declining section of the diversity curve has already been reached.

It was PIELOU (1966, 1975) who first described the basis of the method as OPT here, and similar results were obtained by LLOYD, INGER and KING (1968) as well.

In order to state the extent to which the rarely-occurring species influence the diversity values and to see whether it is worthwhile to continue counting under the microscope to find some newer, rarely-occurring species; two kinds of investigation were carried out;

— the percentage of the total count was calculated which gives 50% and 95% resp. of the diversity values (Table 5). It was stated that 50% of the diversity values are given by the 8 most frequent species (12.8% of the count of species) in the average of the three research areas, while 95% are given by 43 species (68% of the count of species). The data of an arbitrarily chosen sample are given in Fig. 2. As it can be seen also in the Figure the five most frequently-occurring species (10% of the count of species) give 50% of the

Table 6

Quantitative data on the phytoplankton of Lake Velence in 1972
*(i/1 = 1000 individual per litre; * = new for the Lake Velence)*

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
Cyanophyta				
1. *Anabaena* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	+
	O	—	—	398.0
2. *Anabaenopsis hungarica* Halász	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	+
3. *Aphanizomenon* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	36.0
*4. *Aphanocapsa delicatissima* W. et G. S. West	A	—	—	—
	M	—	—	—
	J	4.0	—	—
	S	—	—	—
	O	—	—	—
5. *Aphanocapsa* sp.	A	—	+	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	21.7	—
*6. *A. elachista* var. *planctonica* G. M. Sm.	A	—	—	36.0
	M	+	+	—
	J	40.0	+	217.3
	S	13.0	27.1	217.0
	O	+	+	109.0
7. *Chroococcus minimus* (Keissl.) Lemm.	A	—	—	—
	M	—	10.8	—
	J	—	—	—
	S	—	—	+
	O	—	—	—
8. *C. minor* (Kg.) Näg.	A	5.4	—	—
	M	—	—	—
	J	21.0	—	—
	S	—	—	—
	O	—	—	—
9. *C. minutus* (Kg.) Näg.	A	—	—	—
	M	32.6	—	+
	J	—	—	27.1
	S	10.8	27.1	217.0
	O	—	+	72.0
10. *C. turgidus* (Kg.) Näg.	A	—	—	—
	M	17.3	—	—
	J	8.0	—	—
	S	+	—	—
	O	—	32.6	—

Table 6 (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
11. *Gloeococcus* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	+	—	—
	O	—	—	—
12. *Gomphosphaeria compacta*	A	+	97.8	870.0
(Lemm.) Strm.	M	19.5	130.4	942.0
	J	4.0	—	4,266.3
	S	43.4	5.4	72.0
	O	8.6	32.6	434.0
13. *G. lacustris* Chod.	A	32.6	179.3	181.0
	M	23.9	103.2	543.0
	J	30.0	43.4	1,114.1
	S	34.7	48.9	217.0
	O	17.3	54.3	543.0
14. *Lyngbya limnetica* Lemm.	A	5.4	—	36.0
	M	—	—	833.0
	J	4.0	+	4,918.5
	S	—	—	26,413.0
	O	2.1	—	35,254.0
15. *Lyngbya* sp.	A	—	—	—
	M	—	—	—
	J	—	—	244.5
	S	—	+	—
	O	2.1	—	—
16. *Merismopedia glauca* (Ehr.)	A	—	—	—
Näg.	M	19.5	—	36.0
	J	—	—	—
	S	4.3	—	+
	O	2.1	—	—
*17. *M. minima* Beck.	A	10.8	10.8	—
	M	—	92.3	326.0
	J	34.0	10.8	3,423.9
	S	2.1	10.8	8,369.0
	O	4.3	32.6	978.0
18. *M. punctata* Mey.	A	—	—	—
	M	+	—	—
	J	21.0	5.4	+
	S	13.0	+	—
	O	4.3	—	—
19. *M. tenuissima* Lemm.	A	+	+	—
	M	—	—	—
	J	—	—	—
	S	—	—	36.0
	O	—	—	—
20. *Microcystis aeruginosa* Kg.	A	—	—	—
	M	—	—	—
	J	13.0	—	—
	S	—	—	—
	O	—	—	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
21. *M. flos-aquae* (Wittr.) Kirchn.	A	—	—	72.0
	M	—	—	—
	J	—	—	—
	S	2.1	—	—
	O	6.5	10.8	—
*22. *M. pallida* (Kg.) Lemm.	A	—	—	+
	M	—	—	36.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
*23. *M. pulverea* (Wood) Forti	A	—	—	—
	M	—	—	—
	J	—	+	+
	S	—	—	—
	O	—	—	—
24. *Microcystis* sp.	A	—	+	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	2.1	10.8	—
25. *Oscillatoria amphibia* Agh.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
*26. *O. brevis* (Kg.) Gom.	A	—	—	—
	M	2.1	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
*27. *Oscillatoria chlorina* Kg.	A	—	—	—
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	—	—
28. *O. irrigua* (Kg.) Gom.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
29. *O. pseudogeminata* G. Schmid.	A	—	—	1,341.0
	M	—	—	3,478.0
	J	—	—	326.0
	S	—	—	5,978.0
	O	—	—	16,522.0
30. *Oscillatoria* sp.	A	—	—	—
	M	—	+	—
	J	—	—	—
	S	—	—	—
	O	+	10.8	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
31. *Phormidium* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
*32. *Pseudanabaena catenata* Lauterborn	A	+	—	—
	M	—	—	36.0
	J	—	—	—
	S	—	—	—
	O	+	—	—
*33. *Radiocystis geminata* Skuja	A	—	—	—
	M	—	—	—
	J	—	+	—
	S	—	—	—
	O	—	—	—
*34. *Raphidiopsis mediterranea* Skuja	A	—	—	—
	M	—	—	—
	J	—	—	1,548.9
	S	—	—	72.0
	O	—	—	253.0
*35. *Romeria leopoliensis* (Raciborski) Koczwara	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	+
	O	—	—	—
36. *Spirulina maior* Kütz.	A	+	—	+
	M	—	—	109.0
	J	—	—	—
	S	—	—	36.0
	O	—	—	36.0
37. *Synechocystis aquatilis* Sauvageau	A	—	—	1,051.0
	M	—	—	2,065.0
	J	—	4,331.6	27.1
	S	—	—	—
	O	—	—	—
38. *S. salina* Wisłouch	A	5.4	59.7	36.0
	M	78.2	86.9	—
	J	186.0	43.4	7,500.1
	S	117.3	3,570.7	5,688.0
	O	8.6	32.6	109.0
39. Unknown *Cyanophyta* I.	A	—	—	—
	M	4.3	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
40. Unknown *Cyanophyta* II.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	471.0
	O	—	—	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
41. Unknown *Cyanophyta* III.	A	—	—	—
	M	—	130.4	—
	J	—	—	—
	S	21.7	16.3	253.0
	O	—	21.7	—
Euglenophyta				
42. *Euglena acus* Ehr.	A	—	—	36.0
	M	—	—	+
	J	—	—	+
	S	—	—	—
	O	—	—	—
*43. *E. ehrenbergii* Klebs.	A	—	—	—
	M	—	—	—
	J	—	+	—
	S	—	—	—
	O	—	—	—
*44. *E. klebsii* (Lemm.) Mainx	A	—	—	36.0
	M	—	—	72.0
	J	—	—	—
	S	—	—	36.0
	O	—	—	+
*45. *E. oxyuris* Schmarda	A	—	—	+
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	+	—
*46. *E. oxyuris* f. *minima* Bourr.	A	—	—	—
	M	—	+	+
	J	—	—	—
	S	2.1	—	—
	O	—	—	—
*47. *Euglena polymorpha* Dang.	A	—	—	761.0
	M	—	—	+
	J	—	+	—
	S	—	—	—
	O	—	—	—
*48. *E. spathirhyncha* Skuja	A	—	—	—
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	—	—
49. *E. tripteris* (Duj.) Klebs	A	—	16.3	—
	M	—	5.4	—
	J	+	10.8	135.8
	S	+	+	+
	O	+	10.8	36.0
50. *Euglena* sp. I.	A	10.8	10.8	109.0
	M	4.3	5.4	72.0
	J	4.0	—	190.2
	S	—	5.4	326.0
	O	2.1	+	36.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
51. *Euglena* sp. II.	A	5.4	—	36.0
	M	2.1	—	—
	J	—	—	+
	S	—	+	36.0
	O	—	—	181.0
52. *Euglena* sp. III.	A	—	—	—
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	—	+
*53. *Lepocinclis ovum* (Ehr.) Lemm.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	+	36.0
	O	—	—	—
*54. *L. ovum* var. *conica* All. et Lef.	A	—	—	—
	M	—	—	—
	J	—	+	407.0
	S	—	—	—
	O	—	—	—
*55. *L. salina* Fritsch	A	—	5.4	+
	M	+	—	36.0
	J	4.0	+	—
	S	+	5.4	36.0
	O	—	—	+
*56. *Phacus acuminatus* Stokes	A	—	—	+
	M	+	—	36.0
	J	—	—	+
	S	—	—	+
	O	—	—	—
57. *P. aenigmaticus* Drez.	A	—	—	+
	M	—	5.4	—
	J	—	—	—
	S	—	—	—
	O	—	—	+
*58. *P. curvicauda* Swirenko	A	+	+	+
	M	+	+	36.0
	J	+	5.4	+
	S	+	—	36.0
	O	+	—	+
*59. *P. platalea* Drez.	A	+	5.4	+
	M	+	5.4	36.0
	J	—	+	163.0
	S	—	10.8	+
	O	—	+	—
*60. *P. indicus* Skvortz.	A	—	—	—
	M	—	+	—
	J	—	—	—
	S	—	—	+
	O	—	—	+

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*61. *P. pleuronectes* (O. F. M.) Duj.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	+
62. *P. pyrum* (Ehr.) Stein	A	+	+	+
	M	+	10.8	72.0
	J	—	+	380.4
	S	—	10.8	181.0
	O	—	+	145.0
*63. *P. pusillus* Lemm.	A	—	5.4	+
	M	—	—	—
	J	—	—	271.7
	S	—	+	36.0
	O	—	—	109.0
64. *P. skujae* Skvortz.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	36.0
65. *Trachelomonas* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	+	—
	O	—	—	—
Chrysophyta				
*66. *Achnanthes minutissima* var. *cryptocephala* Grun.	A	65.2	—	—
	M	23.9	10.8	—
	J	47.0	—	—
	S	13.0	—	—
	O	21.7	—	—
*67. *Amphiprora alata* Kütz.	A	+	+	+
	M	2.1	5.4	72.0
	J	+	—	—
	S	2.1	5.4	—
	O	4.3	32.6	—
*68. *Amphora ovalis* var. *pediculus* Kütz.	A	+	+	—
	M	—	5.4	109.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
*69. *Asterionella formosa* Hass.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
70. *Caloneis* sp.	A	5.4	—	—
	M	+	+	—
	J	—	—	—
	S	—	—	—
	O	—	—	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
71. *Campylodiscus clypeus* Ehr.	A	—	+	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	+	—
*72. *C. clypeus* var. *bicostata* (W. Sm.) Hust.	A	—	—	—
	M	—	+	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
73. *Chaetoceros mülleri* Lemm.	A	—	—	—
	M	—	—	—
	J	17.0	5.4	81.5
	S	—	5.4	—
	O	—	—	—
74. *Cocconeis placentula* var. *euglypta* (Ehr.) Cl.	A	5.4	—	36.0
	M	+	+	—
	J	+	—	—
	S	—	—	—
	O	2.1	—	—
*75. *Cyclotella comta* (Ehr.) Kütz	A	—	—	—
	M	—	—	—
	J	—	—	923.9
	S	—	—	—
	O	—	—	—
*76. *C. meneghiniana* Kütz.	A	5.4	—	290.0
	M	6.5	38.0	543.0
	J	8.0	—	—
	S	30.4	48.9	—
	O	8.6	10.8	72.0
*77. *C. ocellata* Pant.	A	54.3	81.5	—
	M	10.8	288.0	1,050.0
	J	8.0	48.9	353.2
	S	—	108.6	1,739.0
	O	8.6	119.5	1,086.0
78. *Cyclotella* sp.	A	—	—	—
	M	—	—	—
	J	26.0	—	—
	S	—	—	—
	O	—	—	—
*79. *Cymatopleura solea* (Bréb.) W. Sm.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	+
*80. *Cymbella lanceolata* (Ehr.) V. H.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*81. *C. ventricosa* Kütz	A	+	—	—
	M	—	—	—
	J	8.0	—	—
	S	—	—	—
	O	—	—	—
82. *Cymbella* sp. I.	A	—	—	—
	M	+	—	—
	J	—	—	—
	S	+	—	—
	O	—	—	—
83. *Cymbella* sp. II.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	+	—	—
	O	—	—	—
*84. *Diatoma elongatum* (Lyngb.) Ag.	A	10.8	—	—
	M	6.5	+	—
	J	+	—	—
	S	2.1	—	—
	O	+	—	—
*85. *Fragilaria crotonensis* Kitt.	A	—	—	—
	M	+	—	—
	J	—	—	—
	S	—	—	—
	O	2.1	—	—
86. *Fragilaria* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	2.1	—	—
	O	—	—	—
87. *Gyrosigma* sp.	A	—	—	+
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	+
88. *Mastogloia* sp.	A	+	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	2.1	—	—
*89. *Navicula cryptocephala* Kütz.	A	+	—	—
	M	—	5.4	36.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
*90. *N. cryptocephala* var. *veneta* (Kütz.) Grun.	A	5.4	+	145.0
	M	+	—	—
	J	4.0	5.4	163.0
	S	—	—	—
	O	+	—	36.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*91. *N. cuspidata* Kütz.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	+	—	—
	O	—	—	—
*92. *N. hungarica* Grun.	A	—	—	72.0
	M	—	—	109.0
	J	—	—	+
	S	—	—	—
	O	—	—	—
*93. *N. hungarica* var. *capitata* (Ehr.) Cl.	A	—	—	—
	M	—	—	109.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
*94. *N. placentula* f. *lanceolata* Grun.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	+
	O	—	—	—
*95. *N. radiosa* Kütz.	A	+	+	—
	M	6.5	—	—
	J	4.0	—	—
	S	+	—	—
	O	2.1	—	—
96. *Navicula* sp. I.	A	+	16.3	+
	M	13.0	5.4	—
	J	+	—	—
	S	2.1	—	—
	O	2.1	—	218.0
97. *Navicula* sp. II.	A	—	—	—
	M	6.5	+	—
	J	—	—	—
	S	2.1	—	—
	O	—	—	145.0
98. *Neidium* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
*99. *Nitzschia acicularis* W. Sm.	A	—	5.4	254.0
	M	—	5.4	290.0
	J	—	—	+
	S	—	—	36.0
	O	—	—	—
*100. *N. hungarica* Grun.	A	—	+	36.0
	M	2.1	+	—
	J	—	—	—
	S	—	—	—
	O	—	+	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*101. *N. longissima* var. *reversa* Grun.	A	—	—	—
	M	—	—	—
	J	—	—	190.2
	S	—	—	5,289.0
	O	—	—	36.0
*102. *N. palea* (Kütz.) W. Sm.	A	+	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
103. *Nitzschia* sp. I.	A	—	21.7	—
	M	13.0	16.3	18,478.0
	J	4.0	—	7,717.5
	S	4.3	5.4	—
	O	4.3	10.8	36.0
104. *Nitzschia* sp. II.	A	—	—	—
	M	—	5.4	1,739.0
	J	—	—	—
	S	2.1	—	—
	O	2.1	—	145.0
105. *Nitzschia* sp. III.	A	—	—	—
	M	—	—	36.0
	J	—	—	—
	S	—	—	109.0
	O	—	—	—
*106. *Rhoicosphenia curvata* (Kütz.) Grun.	A	+	+	—
	M	4.3	—	—
	J	+	—	—
	S	—	—	—
	O	+	—	—
*107. *Rhopalodia gibba* (Ehr.) O. Müll.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	+	—	—
	O	—	—	—
108. *Stauroneis* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
109. *Stephanodiscus* sp.	A	—	—	—
	M	—	—	—
	J	4.0	—	—
	S	—	—	—
	O	—	—	—
*110. *Surirella ovata* Kütz.	A	—	—	—
	M	—	10.8	—
	J	—	—	—
	S	—	—	—
	O	—	—	+

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*111. *Synedra acus* Kütz.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	+	—	—
	O	2.1	—	181.0
*112. *S. acus* var. *angustissima* Grun.	A	—	—	36.0
	M	—	—	—
	J	+	—	—
	S	—	—	—
	O	—	—	—
*113. *S. tabulata* (Ag.) Kütz.	A	—	—	—
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	—	—
114. *Synedra* sp.	A	—	—	—
	M	—	—	—
	J	+	—	—
	S	—	—	—
	O	—	—	—
115. *Goniochloris laevis* Pascher	A	+	16.3	72.0
	M	2.1	43.4	—
	J	134.0	59.7	326.0
	S	128.2	108.6	145.0
	O	13.0	+	72.0
116. *G. mutica* (A. Braun) Fott	A	—	—	—
	M	—	—	—
	J	—	—	81.5
	S	—	—	—
	O	—	—	—
*117. *Kephyrion inconstans* (Schm.) Bourr.	A	—	—	—
	M	—	—	—
	J	4.0	—	—
	S	—	—	—
	O	—	—	—
Pyrrophyta				
118. *Cryptomonas erosa* Ehr.	A	222.8	179.3	471.0
	M	30.4	48.9	36.0
	J	91.0	—	353.2
	S	67.3	59.7	543.0
	O	65.2	173.9	833.0
*119. *C. erosa* var. *reflexa* Mars.	A	—	—	—
	M	28.2	21.7	—
	J	21.0	—	—
	S	+	—	—
	O	8.6	+	—
*120. *C. ovata* Ehr.	A	—	—	—
	M	6.5	5.4	—
	J	—	—	217.3
	S	32.6	86.9	—
	O	23.9	54.3	109.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*121. *C. pusilla* Bachm.	A	1,750.0	516.3	218.0
	M	369.5	97.8	4,710.0
	J	147.0	—	—
	S	54.3	27.1	36.0
	O	656.5	54.3	2,246.0
*121. *C. rostrata* Troitzk.	A	—	10.8	—
	M	—	—	36.0
	J	17.0	—	—
	S	—	—	—
	O	—	—	—
123. *Gloenodinium* sp.	A	—	16.3	—
	M	—	—	—
	J	8.0	—	—
	S	—	5.4	—
	O	—	—	72.0
124. *Gymnodinium* sp.	A			+
	M	—	—	—
	J	—	—	27.1
	S	—	—	+
	O	—	—	—
125. *Peridiniopsis borgei* Lemm.	A	—	—	—
	M	52.1	+	—
	J	34.0	16.3	—
	S	30.4	65.2	—
	O	86.9	76.0	—
126. *Peridinium cinctum* (Müll.) Ehr.	A	+	—	—
	M	+	—	—
	J	—	—	—
	S	2.1	—	—
	O	2.1	—	—
127. *P. inconspicuum* Lemm.	A	—	—	—
	M	19.5	—	—
	J	78.0	+	—
	S	50.0	10.8	—
	O	10.8	+	—
128. *P. pusillum* (Pen.) Lemm.	A	5.4	—	—
	M	52.1	+	—
	J	100.0	5.4	—
	S	21.7	+	—
	O	23.9	—	—
129. *Peridinium* sp.	A	—	—	—
	M	—	—	—
	J	17.0	—	—
	S	—	—	—
	O	—	—	—
Chlorophyta				
130. *Ankistrodesmus acicularis* (A. Br.) Kors.	A	+	—	833.0
	M	—	+	1,594.0
	J	—	—	—
	S	—	—	181.0
	O	—	—	72.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*131. *A. angustus* Bern.	A	5.4	70.6	1,775.0
	M	—	43.4	1,014.0
	J	—	—	271.7
	S	—	—	217.0
	O	—	—	398.0
*132. *A. convolutus* Corda	A	396.7	521.7	—
	M	4,065.1	2,684.8	13,478.0
	J	204.0	—	163.0
	S	578.2	—	—
	O	478.2	—	253.0
*133. *A. longissimus* (Lemm.) Wille	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	36.0
	O	—	—	—
*134. *A. falcatus* (Corda) Ralfs	A	—	—	—
	M	2.1	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
*135. *A. minutissimus* Kors.	A	10.8	206.5	580.0
	M	—	—	688.0
	J	13.0	5.4	163.0
	S	2.1	—	978.0
	O	—	—	507.0
136. *A. pseudobraunii* Belch. et Sw.	A	27.1	114.1	725.0
	M	—	266.3	12,464.0
	J	4.0	—	—
	S	—	—	—
	O	—	—	5,579.0
*137. *A. spiralis* (Turn.) Lemm.	A	+	—	—
	M	8.6	—	—
	J	8.0	—	—
	S	+	—	—
	O	2.1	—	—
138. *Ankistrodesmus* sp.	A	—	—	—
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	—	—
139. *Botryococcus braunii* Kütz.	A	10.8	16.3	—
	M	52.1	38.0	—
	J	39.0	—	+
	S	34.7	+	—
	O	47.8	32.6	—
140. *Chlamydomonas* sp.	A	—	—	—
	M	2.1	10.8	36.0
	J	—	—	27.1
	S	—	—	+
	O	—	—	72.0

Table 6. (continued)

Species	Date	Localities		
		Galler	Nemfogi-tisztás	Fürdető
141. *Chodatella ciliata* (Lagerh.) Lemm.	A	+	—	—
	M	6.5	+	36.0
	J	230.0	701.1	625.0
	S	8.6	119.5	688.0
	O	4.3	+	72.0
142. *C. citriformis* Snow	A	—	—	—
	M	—	—	—
	J	21.0	27.1	+
	S	4.3	10.8	36.0
	O	—	10.8	—
*143. *C. quadriseta* Lemm.	A	—	—	—
	M	+	16.3	109.0
	J	+	10.8	190.2
	S	4.3	38.0	720.0
	O	—	21.7	398.0
144. *Closterium* sp. I.	A	—	+	—
	M	+	—	—
	J	+	—	+
	S	—	—	36.0
	O	2.1	—	—
145. *Closterium* sp. II.	A	+	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
146. *Coelastrum microporum* Naeg.	A	—	—	507.0
	M	26.0	10.8	1,268.0
	J	—	—	271.7
	S	15.2	16.3	72.0
	O	30.4	+	218.0
*147. *C. pseudomicroporum* Kors.	A	+	—	—
	M	2.1	+	—
	J	4.0	10.8	—
	S	2.1	10.8	—
	O	—	—	36.0
*148. *C. sphaericum* Naeg.	A	—	—	—
	M	—	—	—
	J	4.0	16.3	516.3
	S	—	—	72.0
	O	—	—	—
*149. *Coelastrum* sp.	A	—	—	—
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	—	—
150. *Cosmarium bioculatum* Bréb.	A	+	76.0	—
	M	2.1	103.2	145.0
	J	—	293.4	1,494.5
	S	6.5	141.3	942.0
	O	—	195.6	253.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
151. *C. granatum* Bréb.	A	+	—	—
	M	2.1	+	—
	J	+	—	27.1
	S	+	—	—
	O	+	—	—
*512. *C. humile* var. *glabrum* Gutw.	A	—	—	—
	M	6.5	—	—
	J	—	—	—
	S	2.1	—	—
	O	4.3	—	—
153. *C. laeve* var. *minimum* W. et G. S. West.	A	—	—	72.0
	M	2.1	54.3	145.0
	J	65.0	282.6	625.0
	S	8.6	385.8	145.0
	O	8.6	195.6	181.0
*154. *C. margaritiferum* Menegh.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	+	—	—
	O	—	—	—
155. *C. polygonatum* Halász	A	+	86.9	109.0
	M	6.5	152.1	72.0
	J	30.0	440.2	190.2
	S	15.2	65.2	217.0
	O	2.1	217.3	290.0
*156. *C. reniforme* (Ralfs) Arch.	A	—	—	—
	M	2.1	—	—
	J	+	—	—
	S	2.1	—	—
	O	+	—	—
157. *C. trilobulatum* Reinsch.	A	—	—	—
	M	+	—	—
	J	+	—	—
	S	+	—	—
	O	+	—	—
*158. *C. undulatum* var. *minutum* Wittr.	A	—	—	—
	M	+	+	—
	J	13.0	+	+
	S	6.5	+	+
	O	—	10.8	—
*159. *C. venustus* Bréb.	A	—	—	—
	M	4.3	—	—
	J	—	—	—
	S	+	—	—
	O	—	—	—
160. *Cosmarium* sp. I.	A	+	—	—
	M	+	—	—
	J	—	—	—
	S	—	—	—
	O	2.1	+	+

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
161. *Cosmarium* sp. II.	A	+	—	—
	M	—	—	—
	S	4.0	—	—
	O	—	—	—
162. *Cosmarium* sp. III.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
163. *Cosmarium* sp. IV.	A	—	—	—
	M	2.1	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
164. *Cosmarium* sp. V.	A	—	—	—
	M	—	—	—
	J	—	5.4	—
	S	—	—	—
	O	—	—	—
165. *Cosmarium* sp. VI.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	6.5	—	—
	O	—	—	—
*166. *Crucigenia apiculata* (Lemm.) Schmidle	A	—	—	—
	M	—	—	—
	J	—	—	27.1
	S	—	—	—
	O	—	—	36.0
*167. *C. quadrata* Morren	A	—	+	+
	M	2.1	+	36.0
	J	—	—	+
	S	+	+	+
	O	—	—	+
*168. *C. rectangularis* (Naeg.) Gay.	A	—	—	—
	M	6.5	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
*169. *C. pulchra* W. et G. S. West	A	—	—	—
	M	—	—	+
	J	—	—	—
	S	—	—	36.0
	O	—	—	—
170. *C. tetrapedia* (Kirchn.) W. et G. S. West	A	+	48.9	36.0
	M	4.3	59.7	109.0
	J	8.0	76.0	1,059.8
	S	17.3	119.5	1,376.0
	O	8.6	43.4	181.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
171. *Dictyosphaerium ehrenbergianum* Naeg.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	+
	O	—	—	—
*172. *D. pulchellum* Wood	A	—	—	8,986.0
	M	—	—	1,159.0
	J	—	—	54.3
	S	2.1	5.4	145.0
	O	—	—	—
*173. *Didymogenes palatina* Schmidle	A	—	5.4	435.0
	M	—	10.8	253.0
	J	—	—	135.8
	S	—	—	507.0
	O	—	—	36.0
*174. *Elakatothrix lacustris* Korsch.	A	+	21.7	145.0
	M	6.5	92.3	217.0
	J	17.0	27.1	+
	S	19.5	76.0	—
	O	15.2	130.4	+
175. *Euastrum cornubiense* var. *ornatum* Halász	A	+	—	—
	M	4.3	—	—
	J	13.0	—	—
	S	26 0	—	—
	O	15.2	—	—
*176. *Franceia javanica* (Bern.) Hortob.	A	—	—	—
	M	—	—	—
	J	17.0	—	—
	S	—	—	—
	O	—	—	—
*177. *F. ovalis* (Francé) Lemm.	A	—	—	—
	M	—	—	36.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
178. *Franceia* sp.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	4.3	—	—
	O	—	—	—
*179. *Kirchneriella contorta* (Schmidle) Bohl.	A	—	—	72.0
	M	—	—	253.0
	J	21.0	10.8	271.7
	S	—	54.3	2,101.0
	O	—	76.0	145.0
180. *K. lunaris* (Kirchn.) Möb.	A	27.1	38.0	1,014.0
	M	4.3	10.8	—
	J	—	10.8	434.7
	S	8.6	38.0	1,739.0
	O	—	54.3	688.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
181. *K. obesa* (W. et G. S. West) Schmidle	A	—	—	—
	M	—	27.1	—
	J	4.0	5.4	190.2
	S	—	+	290.0
	O	2.1	—	72.0
182. *Oocystis lacustris* Chod.	A	16.3	92.3	2,029.0
	M	67.3	923.9	5,398.0
	J	169.0	510.8	3,804.4
	S	121.7	918.4	7,934.0
	O	69.5	836.9	2,065.0
*183. *O. parva* W. et G. S. West	A	10.8	43.4	36.0
	M	63.0	108.6	—
	J	134.0	27.1	625.0
	S	78.2	70.6	797.0
	O	41.3	—	543.0
*184. *O. solitaria* Wittr.	A	—	—	—
	M	13.0	—	—
	J	—	—	—
	S	4.3	—	—
	O	2.1	—	—
185. *Pandorina morum* (Müll.) Bory	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	2.1	—	—
186. *Pediastrum boryanum* (Turp.) Menegh.	A	5.4	10.8	218.0
	M	+	27.1	360.0
	J	8.0	86.9	597.8
	S	—	81.5	181.0
	O	+	119.5	145.0
187. *P. tetras* (Ehr.) Ralfs.	A	+	10.8	+
	M	+	16.3	72.0
	J	—	5.4	489.1
	S	—	5.4	1,231.0
	O	2.1	+	760.0
*188. *Planktonema lauterbornii* Schmidle	A	—	—	688.0
	M	—	+	326.0
	J	—	—	—
	S	—	—	398.0
	O	—	—	543.0
*189. *Scenedesmus acuminatus* (Lagerh.) Chod.	A	—	—	+
	M	—	+	109.0
	J	—	+	271.7
	S	—	+	+
	O	—	—	+
190. *S. acutus* Meyen	A	—	—	—
	M	+	—	360.0
	J	—	—	—
	S	—	+	290.0
	O	—	—	579.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*191. *S. acutus* f. *alternans* Hortob.	A	5.4	38.0	435.0
	M	+	21.7	3,695.0
	J	—	+	2,391.3
	S	—	5.4	1,920.0
	O	—	—	1,195.0
*192. *S. acutus* f. *costulatus* (Chod.) Uherkov.	A	+	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	10.8	+
*193. *S. arcuatus* Lemm.	A	5.4	+	—
	M	19.5	146.7	360.0
	J	4.0	+	—
	S	15.2	5.4	—
	O	+	43.4	+
*194. *S. armatus* Chod.	A	—	—	—
	M	—	—	253.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
*195. *S. armatus* var. *exaculeatus* Chod.	A	—	—	—
	M	—	—	72.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
*196. *S. columnatus* Hortob.	A	—	—	—
	M	2.1	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
*197. *S. denticulatus* var. *linearis forma*	A	—	—	—
	M	—	—	—
	J	34.0	—	—
	S	67.3	—	—
	O	13.0	+	—
198. *S. ecornis* (Ralfs) Chod.	A	16.3	81.5	—
	M	39.1	—	360.0
	J	21.0	65.2	516.3
	S	6.5	70.6	1,014.0
	O	13.0	32.6	360.0
*199. *S. ecornis* var. *disciformis* Chod.	A	—	38.0	36.0
	M	—	—	—
	J	+	16.3	—
	S	—	21.7	—
	O	—	54.3	72.0
200. *S. ecornis forma*	A	—	—	—
	M	—	168.4	145.0
	J	—	157.6	—
	S	—	929.3	1,050.0
	O	—	782.6	1,630.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*201. *S. granulatus* W. et G. S. West	A	—	—	—
	M	—	—	—
	J	—	—	54.3
	S	2.1	—	72.0
	O	—	—	—
*202. *S. granulatus* f. *elegans* Hortob.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	2.1	—	—
*203. *S. intermedius* Chod.	A	—	10.8	36.0
	M	2.1	—	326.0
	J	—	5.4	54.3
	S	—	—	72.0
	O	+	—	145.0
*204. *S. intermedius* var. *acaudatus* Hortob.	A	—	103.2	—
	M	—	—	—
	J	21.0	—	—
	S	30.4	—	—
	O	10.8	—	—
*205. *S. intermedius* var. *bicaudatus* Hortob.	A	—	—	—
	M	—	—	—
	J	—	—	27.1
	S	—	—	—
	O	—	—	—
*206. *S. lefevrii* var. *semiserratus* Uherkov.	A	—	—	906.0
	M	6.5	10.8	720.0
	J	—	—	978.2
	S	2.1	—	290.0
	O	2.1	—	218.0
*207. *S. opoliensis* P. Richt.	A	+	10.8	36.0
	M	2.1	5.4	—
	J	—	5.4	217.3
	S	—	10.8	+
	O	—	—	—
*208. *S. opoliensis* varietas	A	—	16.3	+
	M	—	21.7	—
	J	+	—	27.1
	S	+	+	—
	O	+	—	—
*209. *S. ovalternus* var. *graevenitzii* (Bernard) Chod.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	+
210. *S. quadricauda* (Turp.) Bréb.	A	+	222.8	616.0
	M	17.3	315.2	2,753.0
	J	13.0	217.3	1,467.4
	S	15.2	244.5	2,536.0
	O	13.0	739.1	3,188.0

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
*211. *S. quadricauda* var. *longispina* (Chod) G. M. Smith	A	5.4	331.5	2,029.0
	M	6.5	309.7	3,333.0
	J	21.0	38.0	1,739.1
	S	2.1	277.1	3,876.0
	O	—	532.6	3,514.0
*212. *S. quadricauda* var. *maximus* W. et G. S. West	A	—	—	72.0
	M	—	—	218.0
	J	—	+	—
	S	—	—	—
	O	—	—	—
*213. *S. quadricauda* var. *mirificus* (Hortob.) Uherkov.	A	—	—	—
	M	—	—	36.0
	J	—	—	—
	S	—	—	—
	O	—	—	—
*214. *S. quadricauda* var. *quadrispina* (Chod.) G. M. Smith	A	27.1	65.2	290.0
	M	2.1	32.6	290.0
	J	8.0	43.4	706.5
	S	2.1	32.6	434.0
	O	4.3	43.4	218.0
215. *S. quadricauda* varietas	A	5.4	—	—
	M	+	—	72.0
	J	—	5.4	—
	S	2.1	—	36.0
	O	2.1	—	—
*216. *S. raciborskii* f. *granulatus* Hortob.	A	—	—	—
	M	—	—	—
	J	—	—	190.2
	S	—	—	—
	O	—	—	—
*217. *S. securiformis* Playfair	A	+	—	—
	M	17.3	—	543.0
	J	—	—	—
	S	—	21.7	720.0
	O	—	—	434.0
218. *S. spinosus* Chod.	A	10.8	114.1	507.0
	M	6.5	43.4	688.0
	J	+	—	298.9
	S	—	54.3	905.0
	O	2.1	76.0	145.0
*219. *S. spinosus* var. *bicaudatus* Hortob.	A	—	—	36.0
	M	—	—	—
	J	—	—	27.1
	S	—	—	—
	O	+	21.7	+
220. *Scenedesmus* sp. I.	A	5.4	130.4	—
	M	6.5	608.7	—
	J	—	108.6	2,201.1
	S	—	—	—
	O	+	—	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
221. *Scenedesmus* sp. II.	A	—	—	—
	M	—	5.4	—
	J	—	16.3	244.5
	S	—	—	—
	O	6.5	—	—
222. *Scenedesmus* sp. III.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	10.8	—
	O	—	—	—
223. *Scenedesmus* sp. IV.	A	—	—	—
	M	2.1	—	—
	J	13.0	152.1	—
	S	—	—	—
	O	—	—	833.0
224. *Scenedesmus* sp. V.	A	—	—	—
	M	—	—	—
	J	+	—	—
	S	—	—	—
	O	—	—	—
225. *Scenedesmus* sp. VI.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	290.0
226. *Schroederia setigera* (Schröd.) Lemm.	A	—	—	—
	M	—	—	398.0
	J	—	+	869.5
	S	—	—	72.0
	O	—	+	36.0
227. *Staurastrum polymorphum* Bréb.	A	—	—	—
	M	—	—	—
	J	—	—	—
	S	—	—	—
	O	+	—	—
*228. *S. punctulatum* Bréb.	A	—	—	—
	M	4.3	—	—
	J	+	—	—
	S	2.1	—	—
	O	+	—	—
229. *Staurastrum* sp. I.	A	—	—	—
	M	4.3	—	—
	J	+	+	81.5
	S	2.1	+	+
	O	—	32.6	—
230. *Staurastrum* sp. II.	A	5.4	—	—
	M	—	—	—
	J	4.0	—	—
	S	—	—	—
	O	—	—	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
231. *Tetraëdron caudatum* (Corda) Ralfs.	A	+	27.1	109.0
	M	—	21.7	145.0
	J	+	27.1	353.2
	S	—	10.8	253.0
	O	—	—	109.0
232. *T. caudatum* var. *incisum* Lagerh.	A	5.4	48.9	290.0
	M	6.5	108.6	760.0
	J	—	5.4	163.0
	S	+	10.8	398.0
	O	—	10.8	145.0
233. *T. minimum* (A. Br.) Hansg.	A	59.7	880.4	1,558.0
	M	67.3	1,125.0	2,826.0
	J	269.0	913.0	2,418.5
	S	102.1	1,250.0	2,210.0
	O	71.7	2,054.3	1,159.0
*234. *Tetraëdron regulare* Kütz.	A	—	—	—
	M	—	—	—
	J	—	—	+
	S	—	—	—
	O	—	—	—
*235. *Tetrastrum glabrum* (Roll.) Ahlstr. et Tiff.	A	—	—	—
	M	—	—	326.0
	J	—	—	244.5
	S	—	—	—
	O	—	—	—
236. *T. staurogeniaeforme* (Schroed.) Lemm.	A	—	16.3	616.0
	M	—	38.0	580.0
	J	—	—	3,125.0
	S	—	48.9	3,514.0
	O	—	10.8	360.0
237. *Tetrastrum* sp.	A	—	—	290.0
	M	—	—	360.0
	J	—	—	—
	S	—	—	145.0
	O	—	—	507.0
*238. *Treubaria triappendiculata* Bern.	A	—	—	—
	M	—	—	—
	J	—	—	81.5
	S	—	—	—
	O	—	—	—
239. Unknown *Chlorophyta* I.	A	+	—	—
	M	—	—	3,260.0
	J	52.0	—	54.3
	S	—	—	579.0
	O	4.3	—	253.0
240. Unknown *Chlorophyta* II.	A	—	—	—
	M	—	—	36.0
	J	—	—	—
	S	—	—	—
	O	—	—	—

Table 6. (continued)

Species	Date	Localities		
		Gallér	Nemfogi-tisztás	Fürdető
241. Unknown *Chlorophyta* III.	A	—	—	—
	M	+	—	—
	J	—	—	—
	S	—	—	—
	O	—	—	—
242. Unknown *Chlorophyta* IV.	A	+	—	—
	M	—	—	—
	J	+	—	—
	S	—	—	—
	O	—	—	—
Algae total	A	2,868.0	4,753.5	32,353.0
	M	5,435.2	8,839.5	98,409.0
	J	2,644.0	8,921.8	66,655.0
	S	1,941.8	9,437.6	98,120.0
	O	1,898.4	7,193.4	89,507.0

Table 7

Diversity (H″) evenness (J″), and count of species individual(s) values calculated from the data of diagonals

Research area	Month	s	H″	J″	s	H″	J″
Nemfogi-tisztás	A	49	4.45	0.79	65	4.45	0.74
	M	62	3.99	0.67	83	4.00	0.63
	J	47	3.05	0.55	65	3.05	0.51
	S	56	3.50	0.60	73	3.50	0.56
	O	46	3.85	0.70	62	3.86	0.65
Gallér	A	37	2.33	0.45	77	2.35	0.38
	M	71	1.99	0.32	96	1.99	0.30
	J	67	4.97	0.82	88	4.98	0.77
	S	64	4.27	0.71	86	4.34	0.68
	O	64	3.64	0.61	94	3.53	0.54
Fürdető	A	56	4.39	0.76	75	4.41	0.71
	M	81	4.45	0.70	85	4.45	0.69
	J	75	4.93	0.79	101	4.96	0.75
	S	75	4.40	0.71	91	4.33	0.67
	O	77	3.62	0.58	97	3.62	0.55

diversity value, and 29 species (62% of the count of species) give 95% of the diversity value. The remaining 18 species only slightly influence the index value. — In order to find new species, the whole base plate was examined, and by summing the data thus obtained to those of the diagonals, the diversity value (H″) and its auxillary parameters (s, J″) were computed.

The data of the Table 7 show that the rarely-occurring species increase the diversity only to the second decimal place and at the same time they decrease the evenness also into the same degree.

Diversity relations of the phytoplankton community of the research areas

In a decreasing sequence the diversity averages in the phytoplankton community collected in three areas of Lake Velence are as follows: Fürdető 4.35, Nemfogi 3.77, Gallér 3.44. The average of the evenness follows the sequence formed on the basis of diversity, while according to the average of the count of species the sequence is Fürdető, Gallér, and the Nemfogi-tisztás (Fig. 3). The largest count of and the highest evenness consequently the highest
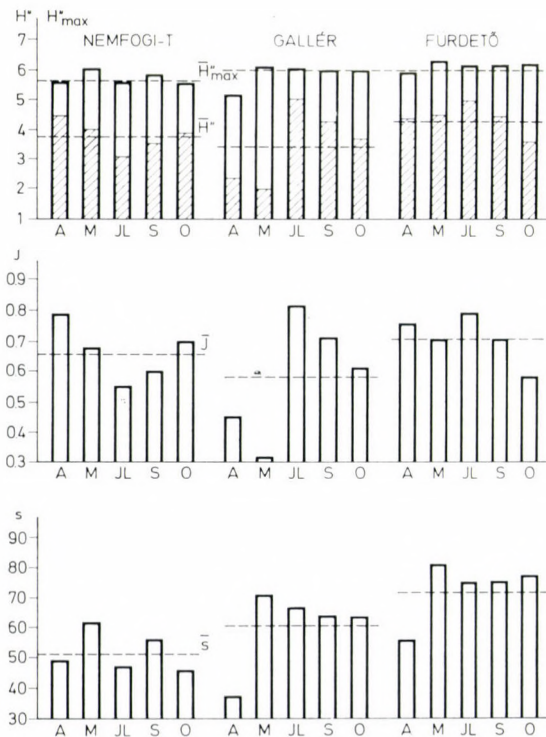
Fig. 3. Changes of diversity, evenness and count of species in the Lake Velence during the year 1972

diversity value occurred in Fürdető. The reason for the smaller diversity, in the Nemfogi-tisztás is the much smaller count of species, while in Gallér the small evenness induced the low diversity value. (This is, however, still high in a general sense.)

The fact that the highest value (4.35) occurs in Fürdető, which is the most polluted part of the Lake (receiving the highest quantity of plant nutrients) needs some explanation. This apparent contradiction can easily be explained, if the inaccurate notion of "pollution" will be studied in more details. If a water receive a large organic pollution, that is its saprobity increases, this will reduce the diversity of the algal community as a whole (STAUB et al. 1970), even though the diversity of certain algal groups may increase at the same time. HAJDU (1978) found that the diversity of *Euglenophyta* divisio increased in fertilized fish-ponds, while the diversity on the basis of the total algal count decreased. The diversity index will be decreased also by pollutants being toxic for certain members of phytoplankton. However, the majority of the algae react to the increase in the level of eutrophication favourably, and parallel to the increase in algal species and individual counts, the diversity index also increases. According to our hypothesis eutrophication influences the diversity as follows. Up to a certain degree, the diversity value increases with the nutrient supply, then, over a certain quantity of algae, the intensive competition (for light and nutrient) lead to reversed effect and the diversity decreases. This critical turning point in the fishponds of Babat was found to be at a count of 100 millions i. $lit.^{-1}$ (HAJDU 1977).

In the course of the present investigations in Lake Velence, similar results were obtained. In 1972, the algal count in Fürdető was 32—98 million i. $lit.^{-1}$. The large content of nutrients in the inflowing pollutants further increased the diversity of the algae ($\bar{H}'' = 4.37$). In 1973—1974, the further increase in the quantity of nutrients led to a remarkable rise in the quantity of phytoplankton (200—500 million i. $lit.^{-1}$), and to the dominance of some species, thus causing a decrease in diversity. In 1973 the diversity value in Fürdető was 1.69; while in 1974 it was as low as 1.57. From the viewpoint of further examinations, 1972 was of vital importance because the turning point might be observed in this year, after that time the increase in eutrophication decrease the diversity index.

It can be concluded that relatively much more information on the phytoplankton may be drawn from the analysis of relatively longer time series than from some samples belonging to a year.

Summary

The species composition and count of phytoplankton were examined at three research areas of Lake Velence which was considered as characteristically different from each other on the basis of earlier examinations. We identified 242 taxa, of which 118 are new to the Lake. By using SHANNON's formula diversity was calculated from the data.

In the course of the methodological examinations, the results obtained by three calculation methods were compared. The most accurate was the optimization of total counts (OPT), the essence of which is that the average highest diversity value is determined on the basis of the smallest possible sample size (being optimal from the viewpoint of microscopic work). This is followed by the accuracy of the "algologists" method (ALG), but this is extremely laboursome. The most disadvantageous is the method of using fixed algal counts (FIX). Although it requires a relatively small amount of work, the deviation from the maximum may be very large. On the basis of the examinations the use of the OPT method is suggested.

Our examinations prove that the rarely-occurring species do not considerably increase the diversity index (they cause changes only at about the second decimal place), therefore it is not worthwhile to "overcount" the samples to discover some rare species.

At three points of Lake Velence, the diversity of phytoplankton is in an increasing sequence, as follows: Fürdető, Nemfogi-tisztás, Gallér. The area of Fürdető polluted by his creeks was the most favourable habitat for plankton algae at the time of our examinations. In 1972, Fürdető was in a state when the inflaxing pollutants with their nutrient supply still increased the diversity of phytoplankton. The further increase in nutrient supply 1973 and 1974 led to a strong decrease in diversity. It is assumed that the eutrophication estimated by the algal count influences the diversity index according to a curve having a maximum (turning point) as a function of saprobity and toxicity. The increase of the latter ones brings about a decrease in the diversity of the total algal count, although the diversity values of certain algal groups can show an increase at the same time.

From the viewpoint of further examinations, 1972 was of vital importance, since the turning point mentioned before might be observed at that time. In the following years the increasing eutrophication decreased the diversity index.

REFERENCES

Archibald, R. E. M. (1972): Diversity in some South African diatom association and its relation to water quality. Water Research **6,** 1229—1238.

Bartha, Zs. (1977): Phytoplankton investigations on Lake Velence (Algal counts and biomass). Acta Bot. Hung. **23,** 1—11.

De Benedictis, P. A. (1973): On the correlations between certain diversity indices. Amer. Nat. **107,** 295—302.

Daday, J. (1897): A magyarországi tavak halainak természetes tápláléka (Natural nutrient supply of the fishes in Hungarian lakes). Budapest, 1—481.

Entz, G. (1927): A Balaton Peridineairól (On the Peridineae of Lake Balaton). — Arch. Balatonicum **1,** 275—342.

Entz, G. (1930): Phaenologische Aufzeichnungen und einige morphologische Beobachtungen an Chrysomonaden. Folia Cryptogamica **1,** 669—742.

Felföldy, L. (1973): A Velencei-tó vízminőségi vizsgálata. 4. részjelentés (Water quality test of Lake Velence. 4. Partial report). VITUKI (Manuscript).

Felföldy, L. (1976): A Velencei-tó vízminőségi vizsgálata. 7. részjelentés (Water quality test of Lake Velence. Part 7). VITUKI (Manuscript).

Gimesi, N. (1936): Chaetoceros a magyar planktonban (Chaetoceros in the Hungarian plankton). Bot. Közl. **33,** 223.

Hajdu, L. (1977): Algal species diversity in two eutrophic fishponds I. Species-individual level. Acta Bot. Hung. **23,** 42—53.

Hajdu, L. (1978): Algal species diversity in two eutrophic fishponds II. Other than species individual levels. Acta Bot. Hung. **23,** 335—351.

Halász, M. (1939): Anabaenopsis hungarica sp. n. im Phytoplankton des Velenceer Sees in Ungarn. Borbasia 1, 69—71.

Halász, M. (1940): A Velencei-tó fitoplanktonja (The phytoplankton of Lake Velence). Bot. Közl. **37,** 251—277.

Lilljelund, L. E. (1977): Diversitets index an översikt. Svensk Bot. Tidskr. **71,** 165—176.

Lloyd, M. — Inger, R. F. — King, F. W. (1968): On the diversity of reptile and amphibian species in a Bornean rain forest. Amer. Nat. **102,** 497—515.

NOSEK, J. N. (1976): Comparative analysis of some diversity functions under different conditions of sampling in Sandy Meadow. Acta Bot. Hung. **22,** 415—436.

PEET, R. K. (1974): The measurement of species diversity. Annual Review. Ecol. Syst. **5,** 285—307.

PIELOU, E. C. (1966): The measurement of Diversity in Different types of Biological Collections. J. Theoret. Biol. **13,** 131—144.

PIELOU, E. C. (1975): Ecological diversity. Wiley Intersci. Publ. 1—165.

SCHIEFNER, K.—GREGÁCS, M. (1964): Velencei-tavi vízvizsgálatok közegészségügyi értékelése (Evaluation of the water research results related to Lake Velence, from the viewpoints of public health). Hidr. Közl. **44,** 272—275.

STAUB, R.—APPLING, J. W.—HOFSTETTER, A. M.—HAAS, I. J. (1970): The Effects of Industrial Wastes of Memphis and Shelby county on primary plankton producers. Bio. Science **20,** 905—912.

STONEBURNER, D. L.—SMOCK, L. A.—EICHHORN, H. C. (1976): A comparison of two diversity indices used in wastewater impact assessments. J. Water Poll. Control Fed. **48,** 734—740.

UNGER, E. (1925): A Velencei-tó fitoplanktonjára vonatkozó kvantitatív vizsgálatok a vízben leggyakoribb nannoplankton szervezetekről (Quantitative analyses of the phytoplankton in Lake Velence, with respect to the most frequent nannoplankton organisms in the water). Verh. d. Int. Ver. f. Limnol. Innsbruck, 428—435.

WILHM, J. L. (1967): Comparison of some diversity indices applied to populations of benthic macroinvertebrates in a stream receiving organic wastes. J. Water Poll. Control Fed. **39,** 1673—1683.

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EAST AFRICAN BRYOPHYTES, III

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Ecological and bryogeographical data, taxonomic annotations, moreover new localities and the general distribution pattern of 330 species collected by T. PÓCS in the Tanzanian mountain areas and by other collectors in different regions of South East tropical Africa. A large number of the species is reported for the first time from East Africa and six of them are new to the African continent. Taxonomic annotations were carried out by M. BIZOT on *Musci*, first of all on *Fissidens* species, while by T. PÓCS on *Hepaticae* and on some species of *Bryum* and *Rhodobryum*. The authors proposed a few new names: *Frullania vandenberghenii* Pócs nom. nov.; *Lejeunea tuberculiflora* E. W. Jones ex Pócs nom. nov.; and the following new combinations: *Lophocolea muhavurensis* (S. Arnell) S. Arnell ex Pócs comb. nov.; *Campylopus metzlerelloides* (P. Varde et Thér.) Bizot comb. nov.; *Fissidens diaphanodonta* (P. Varde) Bizot comb. nov.; *Fissidens enervis* Sim. ssp. *hedbergii* (P. Varde) Bizot stat. nov.; *Rhodobryum perspinidens* (Broth.) Pócs comb. nov. and finally *Rhodobryum spathulatum* (Hornsch.) Pócs comb. nov. for the species known till now under the name *Rhodobryum ontariense* (Kindb.) Kindb. from North America and Eurasia.

Introduction

Since our first joint publication on East African Bryophytes (BIZOT—PÓCS 1974) we dealt partly with other — Norwegian, Danish, German, American and Belgian — collections made in East Africa (BIZOT—DURY—PÓCS 1976, BIZOT—FRIIS—LEWINSKY—PÓCS 1978, BIZOT—DURY 1978, BIZOT—PÓCS—SHARP 1979, VÁŇA—PÓCS—DE SLOOVER 1979), partly accumulated our new identifications for the present paper, which covers the liverworts and most acrocarpous mosses. The continuation with the pleurocarpous families will be published in the near future in East African Bryophytes V, together with habitat photos, distributional maps and with a geographical analysis on the species discussed in both papers.

During the time elapsed many important publications were presented by different authors, and we became in possession of important revisions not seen before (see the References). In the light of these works we had to revise and rectify many of our data previously published, as the Reader will find the quotations with the species numbers of East African Bryophytes I. in our annotations.

Along the collections of the junior author enriched by new gatherings from his visit on Mt. Kilimanjaro guiding the Hungarian TV Expedition in 1976, we identified a large number of liverwort specimens collected by different specialists of Salisbury University in South tropical African countries, as in Zimbabwe-Rhodesia, Malawi, Lesotho and Mozambique, and deposited in CAH, kindly submitted for identification by M. R. CROSBY (MO), as well the liverworts collected by W. D'ARCY (MO) from Rwanda; bryophytes collected in Zambia by J. KORNAŚ (KRA), in Kenya and in Tanzania by D. J. MABBERLEY (OXF), in Tanzania by

B. J. HARRIS and by R. WINGFIELD (DSM). We received important materials for comparison from BR, H and from PC. We express our kindest gratitudes towards the above collectors, curators and directors of herbaria concerned. The junior author is thankful for the financial support received from the University of Dar es Salaam, Ho Si Minh Teachers' College, Eger, and from the Hungarian Academy of Sciences. We are also indebted to R. GROLLE, E. W. JONES, S. R. GRADSTEIN, S. ORBÁN, P. TIXIER and to J. VÁŇA for identifications or revisions of critical species (see also the abbreviations). The first specimens of the material listed are deposited in EGR, duplicates are distributed among the herbaria of M. BIZOT, now PC, DSM, EA, BP, G, MO and others.

In the species list, after the serial number and species name the Reader finds in many cases important synonyms, further the ecological data and localities of the collected specimens. If the record is new for a larger geographical unit, is marked by an asterisk before its abbreviation. It is followed by the collector's name and number. If the collecting number stands alone within the parentheses, the collection was made by T. PÓCS and his companions enumerated in BIZOT—PÓCS 1974: 398. Collecting numbers of T. PÓCS (in fact locality numbers) higher than 6916 refer to his collections made in Tanzania during the Hungarian TV Expedition, between 21 June and 11 July 1976. The collecting data are followed by the abbreviated name of the identifier: B — M. BIZOT, J — E. W. JONES, G — R. GROLLE, P — T. PÓCS, V — J. VÁŇA. The known distribution is given only in general, referring to our previous papers with detailed data (EAB I, II, IV). A checklist with full records of tropical African liverworts and an other one of the East and South tropical African mosses are under preparation.

The abbreviations used to indicate the substrates of bryophytes:

te: terricolous
ru: rupicolous
li: lignicolous
ct: corticolous
ra: ramicolous
ph: epiphyllous

Abbreviations of the geographical units used by the localities and by the distributional data:

ABE: Aberdare Mts. in Kenya
BYS: Mt. Bysoke in Rwanda
CHE: Cherangani Hills in Kenya
EA: East Africa
EUS: East Usambara Mts. in Tanzania
ELG: Mt. Elgon in Uganda—Kenya
F.R.: Forest Reserve
F. St.: Forest Station
GOL: Gologolo Mts. (Kilombero Range) in Tanzania
KAN: Mt. Kanga in Tanzania
K: Kenya
KEN: Mt. Kenya
KIB: Kiboriani Hills in Tanzania
KIL: Kilimanjaro Mts. in Tanzania
MER: Mt. Meru in Tanzania
MOZ: Mozambique
MUL: Mulanje Mts. in Malawi
NGO: Ngorongoro Crater area in Tanzania
NGU: Nguru Mts. in Tanzania
POR: Poroto Mts. in Tanzania
RHO: Zimbabwe
RUN: Rungwe Mts. in Tanzania
RUW: Ruwenzori Mts. in Uganda—Zaïre
SA: South Africa
SAm: South America
SEA: South East Africa
SHL: Southern Highlands (Mufindi Escarpment) in Tanzania
SPA: South Pare Mts. in Tanzania
T: Tanzania
UKA: Ukaguru Mts. in Tanzania
U.F.R.: University Forest Reserve
ULU: Uluguru Mts. in Tanzania
USG: Usagara Mts. in Tanzania
USB: Usambara Mts. in Tanzania
UZU: Uzungwe Mts. in Tanzania
WA: West Africa
WUS: West Usambara Mts. in Tanzania
Z: Zambia
ZRE: Zaïre

List of species collected

HEPATICAE

Pseudolepicoliaceae

1. **Blepharostoma trichophyllum** (L.) Dum. — On shady lava rocks. *BYS: 3000 m, among *Symphyogyna podophylla* (c. D'Arcy 7966/B); KIL: S of Shira Hut, 3660 m (6927/T); det. P. Altimontane in Africa, EAB I.

Lepicoliaceae

2. **Mastigophora diclados** (Brid.) Nees — Montane forests, ct or ru. *KAN: S 1100—1370 m (6138/N, 6139/AO, 6140/Z); ULU: Mwere v. 1600 m (6258/C); det. P. Palaeotropical, EAB I.

Lepidoziaceae

3. **Lepidozia lacerata** Steph. — RUW: Muteinda rock shelter, Kamsonga v. 3900 m (c. Loveridge 305/A); det. P. EA montane — SA.
4. **Lepidozia truncatella** Nees — RUW: Above Minita Camp, 2700 m (c. Loveridge 394); det. P. EA montane — SA.
5. **Kurzia irregularis** (Steph.) Grolle — In subalpine giant *Erica* heath, ru. *KIL: Umbwe Route 2800—2900 m (6929/Z); det. P. Afroalpine.
6. **Arachniopsis diacantha** (Mont.) Howe — *MOZ: Manica e Sofala Distr., Makurupuni r. (c. King B 22 p.p.); det. P. EAB I.
7. **Bazzania borbonica** Steph. — Elfin woodland, ru. ULU: Lupanga crest 2050 m (6551/K); det. P. EA-SA-Lemurian species.
8. **Bazzania decrescens** (Lehm. et Lindenb.) Trev. — Montane forests, ct, ru. *RHO: Makurupuni r. c. Williams 8, 13. Inyanga Distr., above left bank of Nyamingura r., 1200 m (c. Phipps B66); Melsetter Distr.: Chimanimani Mts. (c. Phipps B27); Umtali Distr., cloudlands 1680 m (c. Eyles 4850 p.p.); *Z: NW Prov., Zambezi source near Mwinilunga, 1580 m (c. Kornaś BR-0024); *MOZ: Manica e Sofala Distr., Makurupuni r. (c. King B22 p.p.); det. P. Widespread in tropical Africa and in Australasia.
9. **Bazzania nitida** (Web.) Grolle — Elfin forest, ph. ULU: Bondwa top, 2100 m (6233/H); det. P. From Cameroon to EA and SA, Mascarenes, SAm, Australia.
10. **Bazzania roccatii** Gola — RUW: Kamsonge v., Muteinda rock shelter, 3900 m (c. Loveridge 304/B); det. P. Afroalpine.

Calypogeiaceae

11. **Calypogeia fissa** (L.) Raddi — Roadcuts, riverbanks in the montane forest belt. *KIL: Marangu Route (2100 m (6365/A); *RHO: Chimanimani Mts. in Melsetter Distr. c. Phipps B31 p.p.; Melsetter Distrs., Bundi on S slopes of Mt. Peza, 1750 m (c. Mitchell 520/B); Kaspiti, 1275 m c. Loveridge (1247 p.p., 1249 p.p.); det. J and P. Circumboreal, but also in tropical and South Africa.

Lophoziaceae

12. **Chandonanthus cavallii** (Gola) S. Arnell — RUW: Kamsonge v., Muteinda rock shelter, 3900 m (c. Loveridge 304/C); *RHO: Vumba Elephant Forest (c. Wild 7672A p.p.); the plants doubtless belong to the above species, but in the knowledge of the ecology of

this typical afroalpine element, in the case of the Rhodesian plant probably a label change is at hand — P. EAB I.

13. **Chandonanthus hirtellus** Web.) Mitt. ssp. **giganteus** (Steph.) Vanden Berghen — BYS: 3000 m (c. D'ARCY 8189); det. P. EAB I, afroalphine.
14. **Tritomaria exsecta** (Schrad.) Loeske—Montane forest, et ct. *RUN: N 2300 m (6334/Z); det. V. Altimontane in Africa, EAB I.
15. **Cuspidatula contracta** (Reinw. et al.) Steph.) — Montane forests, ru. ULU: Mzinga falls, 1450 m (6266/V); det. V. Palaeotropical, EAB I.

Jungermanniaceae

16. **Jamesoniella purpurascens** Steph. — Montane forests, ru, ct. *RUN: Mt. Kyejo E of Tukuyu town, N 1700 m (6770/J); *Z: NW Province, Zambezi source near Mwinilunga, 1580 m (c. KORNAS BR-0024 p.p.); det. V. EA-SA-Lemurian, EAB I.
17. **Marsupella africana** Steph. ex Bonner — In rock cavities of the alpine tussock and semi-desert zones. KIL: Umbwe Route, S of Barranco Hut, 3900 m (6934/F); Shira Plateau, between Shira and Arrow Glacier Huts, 4200—4500 m, a form, which was described by S. ARNELL, as *M. hedbergii* (S. ARNELL 1956: 544); det. P. Afroalpine, EAB IV.
18. **Gymnomitrion laceratum** (Steph.) Horik. — In rock crevices of subalpine *Philippia* and alpine *Helichrysum* communities. KIL: N of Barranco Hut 3900—4000 m (6933/F, 6935/G); near Shira Hut (3700 m (6926/F); det. P. Very disjunct, see EAB I and IV.

Schistochilaceae

19. **Schistochila sphagnoides** (Schwaegr.) Steph. Syn.: *S. limbata* S. Arnell — On rocks. RHO: Melsetter Distr., *Chimanimani Mts. NW of hut, 1620 m (c. MITCHEL 414); Inyanga Distr., above left bank of Nyamingura river, 1200 m (c. PHIPPS B67); det. P. SEA — Lemurian species, see E. W. JONES 1976/A: 37.
20. **Paraschistochila englerana** (Steph.) Schust. Syn.: *S. engleriana* Steph. — Montane forest, ra. *MAD: Diego Suarez, Ambre Mts., Parc Nat. between Petit Lac and Grand Lac, 1200 m (c. CROSBY 7403); Very typical specimen which cannot be classified to *P. neesii* (Mont.) Schuster known from Madagascar, det. P. It was known previously only from the old cristalline massifs of East Africa, see E. W. JONES 1976/A: 39.

Lophocoleaceae

21. **Lophocolea concreta** Mont. — Montane forest, ct. *KIL: Nkweseko 1700—1800 m (6358/D); Umbwe Route 1800 m (6351/F); det. J. Widespread in tropical Africa, EAB I, IV.
22. **Lophocolea congoana** Steph. — Montane forests, te, li, ru. *KIL: Umbwe Route 1700—1900 m (6351/C); Marangu Route 1900—2200 m (6364/A, JONES 2221); Kimefu v. above Nkweseko 1850 m (6360/A, JONES 2220); *RHO: Melsetter Distr., Chimanimani Mts. (c. PHIPPS B31); Bundi on S slope of Mt. Peza 1750 m (c. MITCHELL 520/C); det. J and P. Widespread in tropical Africa.
23. **Lophocolea difformis** Nees — On river bank. *RHO: Goromonzi Distr., Ngomakurira, Dombshawa Res. 1350 m (c. LOVERIDGE 1311); det. P. Widespread in tropical Africa, EAB I, IV.
24. **Lophocolea fragrans** (Moris et De Not.) Gott. et al. — Montane forests, ct, Cy. *ULU: Magari peak NNE 1500—1800 m (6296/U); KIL: Umbwe Route 1800 m (6351/E, JONES 2117 p.p.); det. G and J. Atlantic and S Europe, EA, SA, EAB I.

25. **Lophocolea lucida** (Spreng. ex Lehm.) Mont. — Montane forests, *Erica* and other barks. KIL: Marangu Route 2200 m (6365/C, JONES 2134); *RUN: Mt. Rungwe NE 2400 m (6327/GE); det. J. Quite disjunct in tropical Africa and in the neighbouring islands, EAB I.
26. **Lophocolea muhavurensis** (S. Arnell) S. Arnell ex Pócs, **comb. nov.** Basionym: *Chiloscyphus muhavurensis* S. Arnell, Ark. Bot. 3: 526, f. 3 (1956). Near forest line, in scattered *Erica arborea* stand with giant groundsel, on wet rocks among other bryophytes near streamlet. KIL: Charongo v. below Mweka Base Hut, 2985 m (6719/M); det. P. Afroalpine, EAB I. S. Arnell (1959: 543—544) proposed this new combination, without its valid publication, referring to the examination by R. GROLLE, who noticed the *Lophocolea* like terminal perianths of this species (P).
27. **Lophocolea muricata** (Lehm.) Nees — Montane forests, ct or ph on filmy fern leaves. ULU: Bondwa E 1600 m (6181/CC); *RUN: Mt. Rungwe NE 2400 m (6327/GA); det. P and J.

— **Chiloscyphus decurrens** (Reinw., Blume et Nees) Nees in Gott. et al. Syn. Hep.: 173 (1845) is the earlier synonym of *C. mascarenensis* S. Arnell fide Pócs 1976: 96, see also EAB I, No. 19.

Syn. nov.: *Chiloscyphus santoensis* P. Tixier, Bull. Mus. Nat. Hist. Nat. Paris 3^{e} ser. No. 269: 44, f. 2 (1974). By the kindness of prof. TIXIER, I could examine the type of *Ch. santoensis* and found it to be identical with the above species. Its known distribution is now widered from the precambrian massifs of East Africa to Hawaii, Solomon Islands, Samoa and d'Entrecasteux Islands, incl. the New Hebrides: Espiritu Santo, the type locality of *Ch. santoensis*. Annotation by P. (See map 1 in Pócs 1976: 95.)

28. **Conoscyphus trapezioides** (Sde-Lac.) Schiffn. — Montane forest, ra. ULU: Mt. Kifuru N of Bunduki, 2010 m (6915/K); W of Kibungo Mission, 1730 m (6477/K); det. P. Palaeotropic species, EAB I.
29. **Leptoscyphus hedbergii** (S. Arnell) Schust. — Montane forest, ct. *KIL: Mweka Route 2000—2500 m (6717/J); det. G. Afroalpine, known from altitude 3200—3990 m.
30. **Leptoscyphus infuscatus** (Mitt.) E. W. Jones — RUW: Muteinda rock shelter, Kamsonge v., 3900 m c. LOVERIDGE (298/A); Above Miniba Camp, 2700 m, c. LOVERIDGE (394); d. P Tropical Africa, EAB I.

Plagiochilaceae

31. **Plagiochila barteri** Mitt. — Montane forest. *RHO: Umtali District, Vumba Elephant Forest (c. WILD 7672A p.p.); the other part of the same gathering contains *Chandonanthus cavallii*, therefore I suppose a probably label change — P. Afromontane species, from Sao-Tomé to Madagascar.
32. **Plagiochila divergens** Steph. var. **capensis** (Steph.) E. W. Jones — *RHO: Melsetter Distr., Kasipiti c. LOVERIDGE 1227; det. P. EA montane, see EAB I, IV. The var. is known from Angola and from the Cape.
33. **Plagiochila ericicola** Steph. — Giant *Erica* heath belt, ru. RUW: Kamsonge v., Muteinda rock shelter 3900 m c. LOVERIDGE (304'D); det. P. Afroalpine, EAB I.
34. **Plagiochila integerrima** Steph. — Lowland forest species. *RHO: Melsetter Distr., Makurupuni forests, rocky bed of Haroni r. 330 m c. KELLY 174; Chimanimani Mts., with *Plagiomnium rostratum* s. l. c. PHIPPS B26b; det. P. Widespread in tropical Africa, EAB IV.

35. **Plagiochila sinuosa** Mitt. — Montane forests, ru, ra. *ULU: Morningside 1450 m (6854/J); *RHO: Melsetter Distr., Chimanimani Mts., below falls on Bondi at N of Bundi Valley Plain, 1630 m (c. MITCHELL 359); det. P. EA montane, EAB IV.
36. **Syzygiella concreta** (Gott.) Spruce — Elfin woodland te and ph! *ULU: Bondwa top 2100 m (6052/AK); Lupanga S 1900—2000 m (6287/AV); det. INOUE, P. South American species (Venezuela, Brasil, Tristan da Cunha) recently discovered in tropical Africa: Rwanda, Rugege Forest.

Acrobolbaceae

37. **Lethocolea congesta** (Lehm.) S. Arnell — Subalpine *Philippia* and alpine *Helichrysum* cushion vegetation, te, ru. *BYS: 3000 m (c. D'ARCY s.n.); KIL: Marangu Route near Horombo Hut, 3700—3800 m (6248/U); Umbwe Route, near the IInd Bivouac and the the Barranco Hut, 3600—3800 m (6932/B, 6794/H); S of Shira Hut in a cave, 3660 m (6927/R); det. V. Afroalpine—South African—Lemurian, EAB I, IV.

Arnelliaceae

38. **Gongylanthus ericetorum** (Raddi) Nees — *RHO: Melsetter Distr., Chimanimani Mts. (c. PHIPPS B40); det. P. W and S Europe, Africa, EAB I.

Adelanthaceae

39. **Odontoschisma africanum** (Pears.) Sim — Elfin forest, ru, ct. *ULU: Magari peak E 2100 m (6297/T); *UKA: Mnyera ridge 2060 m, with propagules (6871/AS); det. V. New for East Africa, previously known only from Cape.
40. **Adelanthus decipiens** (Hook.) Mitt. — Elfin forest, ct. ULU: E edge of Lukwangule Pl. 2350—2450 m (6827/AC); det. P. Atlantic Europe, trop. America and Africa, EAB I.
41. **Adelanthus lindenbergianus** (Lehm.) Mitt. — RUW: Muteinda rock shelter in Kamsonge v. 3900 m, ru, ct (c. LOVERIDGE 321, 302); det. P. Very oceanic, disjunct species with sub-antarctic character, EAB I.

Radulaceae

42. **Radula holstiana** Steph. — RHO: Inyanga Distr. by Namingura r., mossy bank at 900 m (c. PHIPPS B80); Melsetter Distr., Chimanimani Mts. (c. PHIPPS B47 p.p.); det. P. Widespread afromontane species from Cameron to Réunion. It includes the species previously known as *R. meyeri* Steph., too, EAB I.
43. **Radula lindbergiana** Gott. ex Hartm. — Montane forest, ct. RHO: Melsetter Distr., Kasipiti 1200 m c. LOVERIDGE 1278; det. P, confirmed by YAMADA. Rho and SA widespread.
44. **Radula stenocalyx** Mont. — Montane forests, ph. ULU: Mwere v. 1500—1600 m (6176/P); Bondwa top 2100 m (6233/G); Lupanga S 1900—2000 m (6287/AH); det. P. Tropical America and Africa, EAB I.

Frullaniaceae

45. **Frullania apicalis** Mitt. — Epiphyllous in elfin forest. ULU: Bondwa top 2100 m (6233/R); det. P. Widespread montane species in tropical Africa. According to VANDEN BERGHEN it is very seldom epiphyllous, only at places with very high air humidity. (VANDEN BERGHEN 1976/A: 55.)
46. **Frullania bullata** Steph. — Montane forest, ra. *RUN: Mt. Rungwe NE 2500 m (6328/F); det. P. SE African — Lemurian.

47. **Frullania depressa** Mitt. — Montane forests, ct. NGO: vicinity of Crater View on S rim, 2160 m (c. CROSBY 8657); KIL: Umbwe Route 2700 m (6194/U); det. P. Widespread in tropical Africa.
48. **Frullania diptera** (Lehm. et Lindenb.) Gott. et al. — Relatively dry montane forests, ct. *SPA: WNW of Kisiwani, Mt. Kwizu E 1000 m (6716/U); MER: Ngurdoto Crater rim 1800 m (6213/T); det. P. Uncommon in tropical Africa.
49. **Frullania ericoides** (Nees) Mont. Syn.: *F. squarrosa* (Reinw., Bl. et Nees) Dum. — Drier forests, woodlands and on sole trees, ct. K: NE of Nairobi, 1700 m (6607/G); ULU: behind Kigurunyembe Mission, 700 m (6723/T); RHO: Yoranmazi Distr., Yilanche Farm 20 miles E of Salisbury, 1350 m (c. MITCHELL 208); det. P. Pantropical, very widespread in Africa.
50. **Frullania lindenbergii** Lehm. — Montane forests, epiphyllous! *KEN: Castle F. St. 2000 m (6604/B); ULU: Top of Mt. Kifuru 2000 m (6915/AA); det. P. EA-SA-Lemurian.
51. **Frullania nodulosa** (Reinw., Bl. et Nees) Nees in Gott. et al. — Lowland rain forests, ct. *ULU: Kimboza F. R. 300 m (6301/A); det. J. Uncommon pantropical species, the first record between Zaire and the Comores.
52. **Frullania serrata** Gott. — Montane forests, ct, ra. RHO: Umtali Distr., Cloudlands, 1560 m (c. EYLES 4851); Inyanga Distr. and Mts., E slopes, 1800 m (c. HENKEL 2627 p.p.); det. P. Palaeotropical, in Africa: mountains from Ethiopia to the Cape.
    ad var. *pertenuis* (Nees) Gott. vergens — NGU: Dunema hill 1400—1500 m (6398/AE); det. P.
53. **Frullania trinervis** (Lehm. et Lindenb.) Gott. et al. — In relatively dry forests and in deciduous woodlands, ct, ru, li. *SPA: Mt. Kwizu E above Kisiwani village, 900—1000 m (6716/V, W); Z: Along the Great East Road 125 km E of Lusaka, 1200 m (6621/w); RHO: Umtali Distr., Cloudlands, 1650 m c. EYLES (4849/A); *LESOTHO: Berea Distr., Mamathe's, 1750 m, in ravine on steep slope (c. JACOT-GUILLARMOD 6344); Maseru Distr., Botsabelo Kloof, 1570 m (c. JACOT-GUILLARMOD 6285); det. P. Widespread in tropical and in South Africa.
54. **Frullania usambarana** Schiffn. var. **reducta** Vanden Berghen — Submontane forests, ru. *ULU: Tegetero Mission, 975 m (6424/S); det. P. Typical EA — Lemurian element, EAB IV.

— **Frunallia vandenberghenii** Pócs, **nom. nov.** instead of
Frullania epiphylla Vanden Berghen, Bull. Jard. Bot. Nat. Belg. 46: 30, f. 7 (1976), which is an illegitimate homonymon of
Frullania epiphylla Hatt. Journ. Hattori Bot. Lab. 38: 236, f. 115 (1974).

Lejeuneaceae

55. **Ptychanthus striatus** (Lehm. et Lindenb.) Nees — Montane forests, ct. RUN: Mt. Rungwe 1600 m (c. ALELJUNG 315); det. P. Pantropical, EAB I.
56. **Schiffneriolejeunea altimontana** Vanden Berghen — Montane forest, ct. *ULU: Lupanga SW above Mbete village, 1500—1700 m (6284/AG); det. Gradstein. New locality of a recently described species known from Rwanda and from East Zaire: Mt. Kahuzi.
57. **Schiffneriolejeunea pappeana** (Nees) Gradst. Syn.: *Ptychocoleus pappeanus* (Nees) Steph. — Montane forest species, more hygrophilous, than the following, ct, ra. *KIL: Umbwe Route, 2100 m (6352/D); EUS: Amani 900 m (6086/BF, 6101/F); *NGU: W of Kwamanga village 1400—1500 m (6398/P); near Mnembule village 1400 m (6437/AB); ULU: Bondwa N, NW, NE 1400—2050 m 12 collectings; Palata N 1675 m (6850/K); Mgeta v. 1600—1640 m (6912/w); Mt. Kifuru S 1700—1850 m (6913/E); Tegetero Mission 975 m (6424/T);

SW ridge of Nguru ya Ndege hill N of Morogoro town 1090—1160 m (6708/S); *SHL: Mufindi Scarp F. R. near the Fishing Camp, 1730—1800 m (6322/F, 6324/D); *RUN: Mt. Rungwe E 2500—2600 m, SW 2450—2600 m (6504/S, 6766/K, 6767/V); det. G and J. Widespread afromontane species, EAB I, IV.

58. **Schiffneriolejeunea polycarpa** (Nees) Gradst. Syn.: *Ptychocoleus molleri* (Steph.) Steph. — Submontane and lowland forest species, also in deciduous woodland and on planted coffee, on sole park and roadside trees, more xerophilous, than the precedent species. KIL: Lyamungu Coffee Res. St. 1260 m (6195/J); between Marangu and Old Moshi 1700—1800 m (6368/O); WUS: Lushoto, hotel park (6240/C); EUS: Amani 900 m (6087/V, 6102/Z, 6381/C); *NGU: W of Kwamanga village, 1400—1500 m (6398/w); ULU: Bondwa NW, N, NE 1200—1850 m 5 records; Mkungwe F. R. 800—1100 m (6218/w); Lupanga W 1500 m (6067/M); Midhani 880 m (6880/A, P, 6881/T, U, AL); Nguru ya Ndege 815—850 m (6706/T); Kitulanghalo F. R. SE 500—770 m (6856/V); det. G, J and P. Widespread in tropical Africa, EAB I.
59. **Caudalejeunea dusenii** Steph. — Submontane rain forest, ph. *ULU: Bondwa N 1400 m on Zenkerella leaf (6855/AM); det. P. Previously known only from WA: Nigeria and Cameroon.
60. **Caudalejeunea hanningtonii** (Mitt.) Steph. — Submontane and montane forests, ct, ra, ph. *ULU: Morningside-Bondwa 1450 m (6854/G); Kinole sawmill 1100 m (6874/AD); Kitulanghalo F. R. E 500—770 m (6856/L); *RHO: Umtali Distr., Vumba, Elephant F. (c. Wild 6450/B); det. P. Tropical Africa, EAB I.
61. **Caudalejeunea lewallei** Vanden Berghen — Montane forests, epiphyllous. *ULU: Mwere v. 1500—1600 m (6176/W, 6221/G); Bondwa E 1600 m (6181/W); Mgeta v. above Hululu Falls, 1600 m (6912/AA); det. P. Burundi, Zaire: Shaba, E Rhodesia, Ethiopia, EAB IV.
62. **Brachiolejeunea tristis** Steph. — Montane forest, epiphyllous. KIL: Umbwe Route 2450 m (6931/P); det. P. Afromontane species, EAB I, IV.
63. **Dicranolejeunea madagascariensis** Steph. — Montane forests, li, ra, ph. *ULU: Mwere v. 1500—1600 m (6176/BJ); Bondwa N 1400—2000 m (6051/DF, 6855/w); RHO: Umtali Distr., Cloudlands, 1650 m (c. Eyles 4849/B); det. P. Afromontane species occurring also in South Africa, EAB I, IV, Vanden Berghen 1978/A: 126.
64. **Marchesinia deslooveri** Vanden Berghen — Montane forest, epiphyllous. *UKA: N ridge of Ikwamba, 1900 m (6866/AC); det. P. A very interesting species recently described from Rwanda: Rugera by Vanden Berghen, 1976/C: 926—929.
65. **Archilejeunea linguifolia** Steph. — On wet, shady, probably irrigated rocks. ZRE: entre Jaluteka and Ganonge, 470 m (c. Louis 8496/B) — BR; det. P. West African lowland forest species.
66. **Taxilejeunea conformis** (Mont.) Steph. — Montane forests, epiphyllous. *KIL: Umbwe Route 2450 m (6931/H); WUS: Mazumbai, University F. R. 1600—1750 m (6371/AT); *ULU: Bondwa E 1600 m (6181/BO); Lupanga S 1900—2000 m (6287/AC); *POR: Near Lake Ngozi 2100 m (6330/AA); det. P. Widespread afromontane species.
67. **Taxilejeunea pulchriflora** Pears. Syn.: *Crossatolejeunea kilimandjarica* S. Arnell — Epiphyllous in montane forests. *ULU: Bondwa N 1450 m (6186/G); Magari peak NNE 1500—1800 m (6296/AG); det. P. Afromontane species from Guinea to the Kilimanjaro.
68. **Leucolejeunea xanthocarpa** (Lehm. et Lindenb.) Evans — Epiphyllous in montane forests. ULU: Bondwa e 1600 m and top 2100 m (6181/AX, 6233/T); Lupanga S 1900—2000 m (6287/AY); det. P. Pantropical, EAB I, IV.
69. **Cheilolejeunea decursiva** (Sde.-Lac.) Schust. Syn.: *Cheilolejeunea tisserantii* Vand. Bergh. et Jovet-Ast — Elfin forest, epiphyllous. ULU: Lupanga ridge SW 1850—2000 m (6287/AW); det. P. Palaeotropic species: Sierra Leone, Central African Republic, Zaire, Tanzania: Uluguru Mts., Sri Lanka, Borneo, Hawaii — see Grolle 1977: 531.

70. **Cheilolejeunea silvestris** (Gott.) E. W. Jones var. **silvestris** — Epiphyllous in montane forests. ULU: Mwere v. 1500—1600 m (6176/BI); Mgeta v. above Hululu Falls, SE of Bunduki, 1600 m (6912/AB); det. P. EA — Lemurian variety, EAB I.

 var. **involuta** (Steph.) E. W. Jones Syn.: *Ch. africana* E. W. Jones, *Pycnolejeunea involuta* Steph. — Epiphyllous in submontane forest. ULU: Kinole sawmill 1100 m (6874/AF); det. P. Tropical African lowland species, EAB I, IV.

71. **Strepsilejeunea brevifissa** (Gott.) Steph.— Epiphyllous in montane forests. *ULU: Mwere v. 1500—1600 m (6176/BF); Bondwa NE and top, 1740—2100 m (6233/P, 6844/GB); KIL: Umbwe Route 2450 m (6931/J); det. P. EA and SA montane, EAB IV.

72. **Anomalolejeunea pluriplicata** (Pears.) Schiffn. — On dead *Erica* twigs in giant heath. KIL: Umbwe Route, 2800—2900 m (6929/NB); det. P. Afroalpine + SA, EAB IV.

73. **Lejeunea acuta** Mitt. Syn.: *Hygrolejeunea acuta* (Mitt.) Vand. Bergh. — Epiphyllous in montane forests. ULU: Mwere v. 1500—1600 m (6176/AK); Bondwa E 1600 m (6181/AK); Lupanga S 1900—2000 m (6287/R); det. P. Afromontane, EAB I.

74. **Lejeunea alata** Gott. Syn.: *Taxilejeunea mitracalyx* Eifrig, *Lejeunea mitracalyx* (Eifrig) Mizut., *Hygrolejeunea alata* (Gott.) Steph. fide GROLLE 1977: 535. — Epiphyllous in montane forest, on *Trichomanes* leaves. *ULU: Magari peak NNE 1500—1800 m (6296/AH); det. P, confirmed by G. New for Continental Africa, previously known from Madagascar, the Mascarenes, Java, Sumatra and Samoa according to GROLLE l.c.

75. **Lejeunea confusa** E. W. Jones — Epiphyllous in montane forest. ULU: Bondwa E 1600 m (6181/AR); det. P. Tropical African species.

76. **Lejeunea cyathearum** E. W. Jones — Epiphyllous in montane forest. KIL: Umbwe Route 2450 m (6931/C). East African montane species.

77. **Lejeunea eckloniana** Lindenb. — Epiphyllous in montane forest and in elfin woodland. KIL: Umbwe Route 2450 m (6931/N); ULU: Bondwa top, 2100 m (6233/AL); det. P. Widespread in tropical and in South Africa.

78. **Lejeunea flava** (Sw.) Nees ssp. **tabularis** (Spreng.) S. Arnell — Submontane and montane forests, ph. ULU: Kinole sawmill 1100 m (6874/AV); Bondwa E and top 1600—2100 m (6233/O); Lupanga S 1900—2000 m (6287/AS); det. P. Pantropical, the ssp. South and tropical African. EAB I, IV.

79. **Lejeunea isophylla** E. W. Jones — Montane forests, ct, ph. KIL: Umbwe Route 1700—1900 m (6351/AB); ULU: Bondwa E and top 1600—2100 m (6188/BB, 6233/K); *RHO: Melsetter Distr., Kasipiti 1200 m (c. LOVERIDGE 1282); Umtali Distr., Cloudlands 1680 m (c. EYLES 4850 p.p.); det. J and P. Tropical African, EAB I, IV.

80. **Lejeunea helenae** Pears. — Montane forest ct. *MER: Malama, 1800 m 6338/C JONES 1760; det. J. Previously known from Angola, Natal and Malawi.

81. **Lejeunea kamerunensis** (Steph.) Vanden Berghen Syn.: *Microlejeunea kamerunensis* Steph. — Montane forests, ct, ph. KIL: Umbwe Route 2450 m (6931/w); ULU: Mwere v. 1500—1500 m (6167/AD); Bondwa E and top 1600—2100 (6181/AD, 6233/AS); *MOZ: Manica e Sofala Distr., W face of Gorongosa Mts. (c. LEACH and CAUNELL 14285A p.p.); det. P. Tropical African, EAB I.

82. **Lejeunea lyratiflora** (Steph.) Vanden Berghen Syn.: *Hygrolejeunea lyratiflora* Steph. Submontane and montane forests, epiphyllous mostly on fern leaves. *NGU: W of Mhonda Mission, 800—1000 m (6400/E); *ULU: Mwere v. 1500—1600 m (6176/AA, 6221/J); Bondwa E 1600 m (6181/AA); det. P. Known only from Cameroon, Rwanda and Burundi.

83. **Lejeunea tuberculiflora** E. W. Jones ex Pócs, **nom. nov.** instead of *Eulejeunea camerunensis* Steph., Spec. Hep. 6: 417 (1923), which became an illegitimate homonymon (orthographic version, see I.C.B.N. Art. 64, Note) of *Lejeunea kamerunensis* (Steph.) Vanden Berghen, Bull. Jard. Bot. Nat. Belg. 42: 446 (1972), based on *Microlejeunea kamerunensis* Steph., Spec. Hep. 5: 812 (1915), in the form, how E. W. JONES (J. Bryol.

7: 33, 1972) used it, without the valid publication of the name of *Lejeunea camerunensis*. He proposed a new name anticipating the above new combination of VANDEN BERGHEN, but did not publish it validly as L. tuberculiflora.

Corticolous. *RHO: Melsetter Distr., Kasipiti, 1200 m (c. LOVERIDGE 1284); det. P. Tropical African species, EAB I.

84. **Lejeunea ulicina** (Tayl.) Tayl. ex Gott. ssp. **ocellifera** (S. Arnell) Schuster Syn.: *Microlejeunea africana* Steph. — Submontane and montane forests, ph, ct. KIL: Umbwe Route 2450 m (6931/M); ULU: Kinole sawmill 1100 m (6874/AE); Mwere v. 1500—1600 m (6176/S); Bondwa E, NE and top, 1600—2100 m (6233/V, 6181/S, 6844/GC); det. P Widespread in tropical and in South Africa, EAB I, II, IV.

85. **Lejeunea villaumei** (Steph.) Grolle Syn.: *Lejeunea arnelliana* Schuster, *Ciliolejeunea capensis* S. Arnell, fide GROLLE 1977: 536. — Montane forests, epiphyllous, corticolous, often on *Cyathea* stem. *KEN: Castle F. St. 2000 m (6603/AB); KIL: Kimafu v. above Nkweseko, 1850 m (6360/B); between Old Moshi and Maua villages, 1750 m (6368/B); ULU: Mwere v. 1500—1600 m (6167/BH); det. J and P. SA-EA-Lemurian species.

86. **Drepanolejeunea madagascariensis** (Steph.) Grolle — Epiphyllous in montane forest. *ULU: Mwere v. 1500—1630 m (6176/AK); det. P. Known from Kenya: Taita hills, from Madagascar and from the Mascarenes.

87. **Leptolejeunea astroidea** (Mitt.) Steph. — Lowland forest, ph. *RHO: Melsetter Distr., Haroni Gorge, on leaves of Rawsonia lucida, 390 m (c. WILD 6668); det. P. Known from Sierra Leone to Zaire and Burundi.

88. **Leptolejeunea maculata** (Mitt.) Schiffn. Syn.: *L. thomeensis* (Steph.) Steph. — Epiphyllous in lowland and submontane forests. ULU: Kinole sawmill 1100 m (6874/AN); Bondwa E 1600 m (6181/AE); det. P. Pantropical species, fide GROLLE 1976: 215.

89. **Leptolejeunea quintasii** Steph. — Epiphyllous in lowland and submontane forests. ULU: Kinole sawmill 1100 m (6874/AK); det. P. Tropical African, EAB I.

90. **Prionolejeunea serrula** Mitt. — Epiphyllous in montane forests. ULU: Bondwa E 1600 m (6181/CD); *RHO: Melsetter Distr., Chimanimani Mts. (c. PHIPPS B31 p.p.); det. P. Tropical Africa, EAB I.

91. **Diplasiolejeunea albifolia** (Tayl.) E. W. Jones — Epiphyllous in montane forests. ULU: Mwere v. 1500—1600 m; Bondwa top 2100 m (6167/AC, 6233/AO); det. P. Tropical African, EAB I.

92. **Diplasiolejeunea cavifolia** Steph. — Epiphyllous in submontane forests. *NGU: Kwamanga E of Mhonda Mission, 1200 m (6397/AE); *ULU: Kinole sawmill 1100 m (6874/AC); Mwere v. 1600 m (6176/BM, 6221/H); Kibungo Mission 1500—1700 m (6475/BB); det. P, revid. G. Pantropical species, EAB I.

93. **Diplasiolejeunea cornuta** Steph. — Epiphyllous and on bamboo stems in montane forests. *KEN: Kamweti track above the F. St. 2400—2700 m (6601/L); KIL: Umbwe Route 2450 m (6931/A); *UKA: Mnyera ridge 2100 m (6740/BD); *EUS: Amani 900 m (6101/AC); ULU: LUPANGA 1800—2000 m (6130/LA, 6287/AP); Mt. Tumbako S ridge 1500 m (6877/AN); Mwere v. 1500—1600 m (6176/AG); det. G and P. EA — Lemurian species, EAB I.

94. **Diplasiolejeunea deslooverii** Vanden Berghen — Montane forest, ph. *ULU: W escarpment of Lukwangule Plateau above Chenzema, 2040—2400 m (6076/CB); det. P. This recently described epiphyllous species was known only from the typle locality: Rwanda, Rugege Forest, 1950—70 m.

95. **Diplasiolejeunea kraussiana** (Lindenb.) Steph. — RHO: Umtali Distr., on *Marattia fraxinea* leaves (c. WILD 6450/A); det. P, confirmed by G. From Cape to Zaire and to Burundi.

96. **Diplasiolejeunea runssorensis** Steph. var. **australis** E. W. Jones — Ramicolous or epiphyllous on rather rigid, thick leaves in montane forests and in elfin woodlands. *UKA:

Mandege F. St 1500 m (6586/F); Mnyera ridge 2100 m (6740/BC); Mamiwa East F. R. 2200 m (c. MABBERLEY M/1390); ULU: Bondwa NW 1600—1800 (6227/w); det. G and Tixier. EA — Lemurian species, all data published in EAB I refer to this variety.

97. **Diplasiolejeunea symoensii** Vanden Berghen — Epiphyllous in montane forests. *K: E of Kericho 2080—2140 m (c. R. B. and A. J. FADEN, J. B. C. CAMERON 1972 s. n.); *KEN: Castle F. St. 1960—2000 m (6604/D); *KIL: Umbwe Route 2450 m (6931/F); *KAN: S 1370 m (6140/Aw); *ULU: Bondwa NE 1740 m (6578/CC); det. G and P. EA montane, EAB I.

98. **Colura berghenii** Jovet-Ast — On dead *Erica arborea* twigs in the giant heath near the forest line. KIL: Umbwe Route, 2800—2900 m (6929/NC); det. P, confirmed by JOVET-AST. Known only from the type locality, in the Kilimanjaro Mts. along Marangu Route near Horombo Hut, at 3225 m.

99. **Colura calyptrifolia** (Hook.) Dum. ssp. **tenuicornis** (Evans) Vand. Bergh. Syn.: *C. tenuicornis* (Evans) Steph. — Epiphyllous in montane forests and in elfin woodlands. *KIL: Umbwe Route 2450 m (6931/E); ULU: Mwere v. 1500—1600 m (6176/H); Lupanga S 1900—2000 m (6287/P); Bondwa top 2100 m (6233/A); det. P. Pantropical.

100. **Colura digitalis** (Mitt.) Steph. — Epiphyllous in montane forests and in elfin woodland. ULU: Mwere v. 1500—1600 m (6176/B); Bondwa top 2100 m (6233/B); det. P. Tropical African.

101. **Cololejeunea africana** (Steph.) Schust. — Epiphyllous in lowland and in submontane forests. T: Kitulanghalo F. R. NE of Morogoro, 730 m (6856/BA); ULU: Mwere v. 1500—1600 m (6176/V); Bondwa E 1600 m (6181/V); det. G and P. Tropical African, EAB I.

102. **Cololejeunea appressa** (Evans) Benedix — Epiphyllous in submontane forests. *ULU: Kinole sawmill, 1100 m (6874/AH); Mwere v. 1500—1600 m (6176/BL); det. P. Pantropical, EAB I.

103. **Cololejeunea bolombensis** (Steph.) Vand. Bergh. — Epiphyllous in submontane and montane forests. ULU: Kinole sawmill, 1100 m (6874/AY); Mwere v. 1500—1600 m (6176/BE); Bondwa top, 2100 m (6233/AR); RHO: Umtali Distr., Vumba, Elephant Forest (c. WILD 6451 p.p.); det. P. Palaeotropical species, from Guinea to New Caledonia, see TIXIER 1975 and VANDEN BERGHEN 1978/B: 447—448.

104. **Cololejeunea cardiocarpa** (Mont.) Evans — Submontane, montane forests, ph. *ULU: Kinole sawmill, 1100 m (6874/AS); Mwere v. 1500 m (6221/F); RHO: Umtali Distr., Vumba, Elephant Forest, on *Marattia* leaves (c. WILD 6450/C); det. P. Pantropical species, EAB I.

105. **Cololejeunea crenatiflora** Steph. — Epiphyllous in submontane forest. *ULU: Kinole sawmill, 1100 m (6874/AO); Mwere v. 1500—1600 m (6176/AM); Bondwa E 1600 m (6181/AM); det. P. Tropical African species.

106. **Cololejeunea cuneifolia** Steph. — Submontane forest, ph. *ULU: Kinole sawmill, 1100 m (6874/AX); det. P. Known from Guinea, Nigeria, Cameroon, Zaire and from Uganda.

107. **Cololejeunea distalopapillata** (E. W. Jones) Schust. — Submontane and montane forests, ph. ULU: Kinole sawmill, 1100 m (6875/BB); *RUN: Mt. Rungwe N of Tukuyu, SW ridge 1950—2050 m (6763/AD); det. P. EA montane species, EAB I.

108. **Cololejeunea duvignaudii** E. W. Jones — Submontane and montane forests, elfin woodland, ph. *ULU: Kinole sawmill, 1100 m (6874/AJ); Mwere v. 1500—160**o** m (6176/J); Bondwa E and top 1600—2100 m (6181/J, 6233/U); Lupanga S 1900—2000 m (6287/AA); RHO: Umtali Distr., Vumba, Elephant F. (c. WILD 6452, 6451 p.p.); det. P. Tropical African, EAB I.

109. **Cololejeunea fadenii** Pócs — Epiphyllous in wet montane forest. KEN: Castle F. St., 1960 m (6604/A); det. P. A few km below the type locality, see PÓCS 1975: 356.

110. **Cololejeunea harrisii** Pócs — Epiphyllous in montane forests. ULU: Mwere v. 1500—1600 m (6176/K); Lupanga S 1900—2000 m (6287/AK); det. P. EA montane species, since its publication (Pócs 1975: 357) De Sloover has collected it also in Rwanda and in Burundi, between 1400 and 2250 m (Vanden Berghen 1977: 242—244).

111. **Cololejeunea leloutrei** (E. W. Jones) Schust. — Submontane and montane forests, ph. ULU: Bondwa top 2100 m (6233/AN); *WUS: Mazumbai U.F.R. 1600—1750 m (6371/Aw); det. P. Tropical African, EAB I.

112. **Cololejeunea malanjae** Steph. Syn.: *C. grossidens* Steph. As Vanden Berghen established (1978: 452); *C. malanjae* is the earlier synonym. Epiphyllous in montane forests. *KIL: Umbwe Route (6931/B); ULU: Kinole sawmill 1100 m (6874/AL); Mwere v. 1500—1600 m (6176/AB); Bondwa NW and top 1900—2100 m (6051/AH, 6233/AG); det. P. Widespread in SE tropical Africa EAB I.

113. **Cololejeunea minutissima** (Sm.) Schiffn. ssp. **utriculifera** Vand. Bergh. — Epiphyllous in montane forest. *KIL: Umbwe Route 2450 m (6931/D); det. P. The species is an oceanic subcosmopolite, while the ssp. *utriculifera* seems to be restricted to the montane forest belt of East Africa. Vanden Berghen (1961: 58) supposed the identity of this subspecies with *Cololejeunea dissita* E. W. Jones. By the kindness of the latter author I was able to study the type and other specimens of *C. dissita*. Althought *C. dissita* might fall within the variability of the really polymorphic *C. minutissima*, it is not the same as the ssp. *utriculifera* and they cannot be synonymized.

114. **Cololejeunea mocambiquensis** S. Arn. — Submontane and montane rain forests, epiphyllous usually on filmy ferns or on mosses. *EUS: Amani 1000 m (6088/Z); *ULU: Bondwa N 1450 m (6186/H); *SHL: Mufindi, near Kilima Tea Factory, 1900 m (6321/D); det. G and P. EA, SA and Lemurian species. *Cololejeunea parva* Vanden Berghen 1977 239 + f. 17 seems to me very closely related or conspecific with the above.

115. **Cololejeunea occidentalis** (E. W. Jones) Vanden Berghen Syn.: *C. cristata* (Steph.) Schuster var. *occidentalis* E. W. Jones — Epiphyllous in submontane rain forest. *ULU: Kinole sawmill, 1100 m (6874/AM); Tropical African, EAB I.

116. **Cololejeunea punctata** (E. W. Jones) Schuster — Submontane rain forest, ph. *ULU: Lupanga NW 1350—1500 m (6066/TA); det. G. East African, EAB I.

117. **Cololejeunea pusilla** Steph. — Submontane and montane forests, ph. ULU: Kinole sawmill 1100 m (6874/AT); Mwere v. 1500—1600 m (6176/I); Bondwa E 1600 m (6181/L); det. P. Tropical African, EAB I.

118. **Cololejeunea usambarica** E. W. Jones — Epiphyllous in montane forests. *KIL: Mweka Route, near Mnangue River v. 1800—1900 m (6212/A, 6343/N); *WUS: Mazumbai U.F.R. 1600—1750 m (6371/AS); ULU: Mwere v. 1500—1600 m (6176/N); Bondwa E 1600—1900 m, top 2100 m (6181/N, 6259/H, 6133/AK); *RUN: Mt. Rungwe SW 1950—2050 m (6763/AE); det. P. East African montane, see Pócs 1975: 365—371.

119. **Cololejeunea zenkerii** (Steph.) E. W. Jones — Epiphyllous in montane forest. *ULU: Mwere v. 1500—1600 m (6176/BG); det. P. Tropical African, EAB I.

120. **Aphanolejeunea capensis** (S. Arnell) S. Arnell Syn.: *Cololejeunea capensis* S. Arnell — Epiphyllous, also on bryophytes or on fern prothallia, in montane forests. *NGU: near Mnembule village, 1400 m (6437/H); ULU: Mwere v. 1500—1600 m (6176/Z); Lupanga S 1900—2000 m (6287/AN); Bondwa top 2100 m (6233/S); det. P. SA and EA montane, Pócs 1975: 36, EAB II.

Pleuroziaceae

121. **Pleurozia gigantea** (Web.) S. Lindb. — Ramicolous in elfin woodland. ULU: Mt. Kifuru N of Bunduki, 2010 m (6915/A); det. P. Palaeotropic species, EAB I, map 2 in Pócs 1977: 96.

Fossombroniaceae

122. **Fossombronia husnotii** Corb. — On roadcut surface in secondary grassland. *ULU: Above Morningside, 1450 m (6004/S); det. P. Mediterranean Europe and N Africa, tropical Africa: Zaire, Shaba; Tanzania, Ngorongoro.

Aneuraceae

123. **Riccardia fastigiata** (Lehm. et Lindenb.) S. Arnell — Montane forest. *RHO: Melsetter Distr., Chimanimani Mts. (c. Phipps B31 p.p.); det. P. Widespread in tropical and in South Africa, EAB I.
124. **Riccardia holstii** (Steph.) E. W. Jones — In *Bryum capillare* cushions on ground of *Senecio* moorland. *KIL: near Horombo Hut, 3700—3800 m (6248/HB); det. P. East African altimontane species, EAB I.

Metzgeriaceae

— **Metzgeria agnewii** Kuwah. — A great part of my records published in EAB I, under No. 162, as *M. violacea*, refers to this species, which seems to be widespread in the montane forest belt of East Africa (see also EAB II): *KAS: E 1400—1600 m (c. Faden s.n.); *KIL: Mweka Route 2500 m (6717/F); NW end of Shira Plateau, above Wasendo Glade 2600—2700 m (6354/D, 6355/B); *KIB: Summit at 2000 m (6569/M); det. P.

125. **Metzgeria consanguinea** Schiffn. — The rest of *M. violacea* records in EAB I under No. 162 is to be referred here according to the view of Kuwahara (in litt.). In addition, the following specimens were identified, as *M. consanguinea*: *KIL: Umbwe Route 2450 m (6931/G); ULU: Mwere v. 1500—1600 m (6176/AO); Bondwa top 2100 m (6233/W); det. P. The species is ramicolous or epiphyllous, on Mt. Kenya lives on bamboo stems in montane forests. Palaeotropical, from East and South Africa to New Guinea.
126. **Metzgeria leptoneura** Spruce Syn.: *M. hamata* auct. non Lindb. — In montane forests. RHO: Inyanga Mts. E 1800 m (c. Henkel 2627 p.p.); det. P. Oceanic subcosmopolite, EAB I.
127. **Metzgeria limbato-setosa** Steph. — Epiphyte in montane forests. ULU: Lupange S 1900—2000 m (6287/AD); MOZ: Manica e Sofala Distr., W face of Gorongosa Mts. (c. Leach and Cannell 14285A p.p.); det. P. EA montane, EAB I, II.
128. **Metzgeria thoméensis** Steph. — Epiphyllous in submontane and in montane forests. ULU: Kinole sawmill, 1100 m (6874/AZ); Mwere v. 1500—1600 m (6176/M); Bondwa E 1600 m (6181/M); Bondwa top 2100 m (6233/AJ); det. P. Tropical African, EAB I.

Pallaviciniaceae

129. **Symphyogyna harveyana** Tayl. — On wet rocks and on streambanks *MUL: L. Ruo Plateau, 1920 m (c. Newman and Whitmore 360/A); *RHO: Inyanga Distr., W slopes of Inyangani Mts. 2250 m (c. Rushworth 927); EA montane, SA, EAB I.
130. **Symphyogyna lehmanniana** Mont. et Nees — On wet rocks, riverbanks and in irrigation furrows. *RHO: Melsetter Distr., Chimanimani Mts. near Haroni r. W of "Stonehenge", 1230 m (c. Phipps B2); Bikita Distr., Turgwe r. 2 miles below Cherere School, 1530 m (c. Pope 80 p.p., 81/C); Melsetter Distr., Kasipiti, 1275 m (c. Loheridge 1256); det. P. SE Africa from Cape up to Shaba and Zambia.

131. **Symphyogyna podophylla** (Thunb.) Nees et Mont. — On wet rocks and in muddy streambanks of the montane forest belt. BYS: 3000 m (c. D'Arcy 7966/A, 7983); RHO: Melsetter Distr., Bundi on S slopes of Mt. Peza, 1750 m (c. Mitchell 520/A); Melsetter Distr., Kaspiti, 1275 m (c. Loveridge 1247 p.p., 1249 p.p.); Chimanimani Mts. (c. Phipps B30); det. P. Widespread in tropical Africa, Tristan da Cunha, and in South America, EAB I.
132. **Symphyogyna volkensii** Steph. — On a mud patch in a dark crevice. RUW: Kamsonge v., Muteinda rock shelter, 3900 m (c. Loveridge 300/A); det. P. Afroalpine: Ruwenzori, Kahuzi, Kilimanjaro, between 2500—3500 m alt.

Targioniaceae

133. **Cyathodium africanum** Mitt. — On wet, shady limestone and other rocks or on soil of lowland and submontane forests. *EUS: Chemka, 550—600 m (6382/A); *RHO: Wankie Distr., moist banks of Zambezi River betw. Matetsi and Deka, 600 m (c. Wild 6084); GOL: below Sanje falls near Sonjo, 300 m (6144/K). The following data refer to sterile *Cyathodium* plants, with a probability being *C. africanum*: *Z: 13 km E of Lusaka, 1300 m (6609/M); ULU: Gambaula F. R. 300 m (6421/A); GOL: Kilombero Scarp F. R. above Kidatu, 600—800 m (6143/K); det. P. Pantropical species, EAB I.

Lunulariaceae

134. **Lunularia cruciata** (L.) Dum. — On shady roadside banks, roadcut surfaces. *ULU: Chenzema Mission, 1700 m (6812/L); *RUN: Mt. Rungwe N 2300 (6334/J); det. J and P. Oceanic subcosmopolite, uncommon in tropical Africa.

Marchantiaceae

135. **Marchantia parviloba** Steph. — On riverbed rocks, stone walls, etc. *RHO: Melsetter Distr., Haroni River bed, 330 m (c. Kelly 164); Gokwe Distr., Sengwa River v. near Charama Pl. (c. Simon 352); Melsetter Distr., Chimanimani Mts., gully behind mountain hut, 1650 m (c. Mitchell 882); det. P. Tropical African, EAB II.
136. **Marchantia wilmsii** Steph. — On wet ground and rocks, riverbanks. RHO: Salisbury Distr., Mazoe Citrus Estate (c. Eyles 4852); Bikita Distr., Turgwe R. 2 km below Cherere School, 1530 m (c. Pope 81/A); Mazoe Distr., Christon Bank, Mazoe headwaters (c. Loheridge 1209); Gokwe Distr., Sengwa R. off S border of Charama Pl., 1220 m (c. Simon 324); det. P. Widespread in tropical Africa from Guinea to Natal.
137. **Dumortiera hirsuta** (Sw.) Nees — On wet, shady rocks, gravel and soil of montane forests. Some of the specimens approach the var. *nepalensis* (Tayl.) Frye et Clark in many aspects. *KEN: Castle F. St. 1960—2000 m (6603/AD); *ULU: Bondwa N 1400—2030 m (c. Harris 448, P 6184/C, 6120/K); Mwere v. 1500—1600 m (6175/C, 6256/G, 6533/H); Kinazi NW 1630 m (6289/K); *SHL: Mufindi, Lupeme Tea Estate, 1750 m (6318/S); *RUN: Mt. Rungwe SW 1700—1800 m (6761/C); *MUL: L. Ruo Plateau, 1800 m (c. Newman and Whitmore 484); *MOZ: Manica e Sofala Distr., Garuso Mt. 1650 m (c. Wild 7675); det. P. Oceanic subcosmopolite, widespread in tropical and in South Africa.

Exormothecaceae

138. **Exormotheca pustulosa** Mitt. — On humus covered granitic rocks in xerophytic *Velloziaceae* bush, on the soil of miombo and other type woodland — usually at places only temporarily wet during the rainy season. *K: Machakos 1800 m (coll. W. D. Foster,

communication by E. W. JONES); *ULU: E foothill of Mt. Mindu called Kasanga, 630 m (6542/L); Mt. Lupanga NW 1200 m (6122/E); Kitulanghalo F. R. ENE of Morogoro, near Mikese village, 450 m (6559/AA); det. P. Mediterranean Europe, Mexico, Atlantic islands, in Africa: Chad, Angola, Erithrea, Transvaal, Cape, Comores and Réunion, see map in BISCHLER 1976: 770.

Ricciaceae

139. **Ricciocarpos natans** (L.) Corda — Floating with current on river surface. Z: Kafue District, Kafue tributary (c. EYLES 3193); det. P. Cosmopolite, in tropical Africa mostly in the big river systems and in the great lakes.
140. **Riccia fluitans** L. s.l. — In springs, streambeds, often underwater. RHO: Mazoe Distr., Christon Bank, Mazoe Hedwaters (c. LOVERIDGE 1217); Marandelles Distr., Ruzain, 1600 m (c. EYLES 3885); det. P. Cosmopolite and widespread in tropical Africa — see remarks in EAB IV.
141. **Riccia nigrosquamata** E. W. Jones Syn.: *R. berriei* E. W. Jones — On humus covered roadside rocks. *UZU: Kitonga gorge near Kokoto, 1000 m (6316/A, JONES 2252); det. J. Tropical African: Sierra Leone, Nigeria, Zaire?, Dar es Salaam in Tanzania.

Anthocerotaceae

142. **Phaeoceros laevis** (L.) Prosk. ssp. **carolinianus** (Michx.) Prosk. — On moist streambanks. MUL: L. Ruo Plateau, 1800 m (c. NEWMAN and WHITMORE 484); RHO: Bikita Distr., Turgwe R. 2 miles below Cherere School, 1530 m (c. POPE 80 p.p.); Inyanga Distr., near path to summit of Inyangani Mt. 2200 m (c. RUSHWORTH 914); det. P. Cosmopolite, widespread in tropical Africa.

MUSCI

Fissidentaceae

143. **Fissidens algarvicus** Solms. — Terricolous, at relatively dry places. *WUS: Mazumbai U.F.R. 1500 m (6370/BA, BB); *ULU: Valley behind Morogoro TTC, 1000 m (6046/U); near Morningside, 1250 (6004/F p.p., 6203/L p.p.); Mzinga v. 1400 m (6266/J); Chenzema Mission 1700 m 6812/D p.p., E, O; det. B. Atlantic and Mediterranean Europe and North Africa — new for tropical Africa.
144. **Fissidens ambiguus** Bizot! — Terricolous and sometimes on barks in submontane and montane forests. *EUS: Amani, Hunga v., 880 m (6514/E); *ULU: Mzinga v. 1400 m (6266/G, 6290/AA p.p.); *UKA: Near Mandege F. St. 1500—1600 m (c. MABBERLEY 1348, P 6586/A); det. B. Known only from the type locality in WUS. BIZOT described many new species from the East African collections of PÓCS and his co-workers in the Rev. Bryol. et Lichénol. 40: 101—138 (1974), but he failed to indicate the exact location of holotype specimens. Therefore the Index Muscorum Supplementum: 1974—1975 by CROSBY (Taxon 26: 285—307, 1977) could not accept their publication, as valid. These names declared to be invalid were validated by PÓCS (Fol. Hist. nat. Mus. Matrensis 4: 15—36, 1977). The names validated that way and occurring in our enumeration are marked by "!" after BIZOT's name.
145. **Fissidens androgynus** Bruch — Corticolous, seldom rupicolous in montane forests. *KEN: near Castle F. St. 1960—2020 m (6602/A, B, 6605/B); *MER: E 2650 m (6522/A); *ULU: Bondwa NE 1600 m (6577/B); Tegetero Mission 975 m (6424/K, R); *KIP: Kitulo Plateau

edge near Kigoma village, 2575—2685 m (6511/C, D, 6750/N, O, AN); det. B. Known from Zambezi to Cape.

146. **Fissidens angolensis** Welw. et Dub. — Terricolous and on *Cyathea* bark in submontane and montane forests. *KIL: Mweka, Mawingo Estate, 1350 m (6349/AE); *WUS: Mazumbai U.F.R. 1750—1880 m (6372/CA); det. B. Tropical African, EAB II.

147. **Fissidens asplenioides** Hedw. — On shady rocks and on soil of submontane and montane forests, sometimes in the Ericaceous belt. MER: Kitoto 2450—2650 m (6340/AE); Njeku gorge 2650 m (6521/D); KIL: Kikafu gorge near Kyere, 1500 m (6347/K, L); Mawingo Estate near Mweka, 1350 m (6349/AD); Kinukamari falls near Marangu, 1500 m (6237/A, D); Charongo v. near Mweka Base Hut, 2985 m (6719/C); WUS: Mazumbai U.F.R. 1500 m (6370/BJ); ULU: Waterfall above Morningside, 1500 m (6053/A); Morningside 1250 m (6004/J); Bondwa 1400—1800 m (6050/AM, 6007/G, H, J, K, 6006/G, 6055/C); Mzuazi v. NNE of Kinole, 845 m (6882/H); Mzinga Falls, 1150 m (6265/K); Msanga Falls above Mzinga village (6110/K); Mwere v. 1500—1600 m (6157/A, 6158/D, 6220/B, 6257/B, 6853/H); Mgeta v. in bamboo forest, 2215 m (6829/P); Lukwangule Plateau 2400 m: (6078/C); KAN: 1200—1300 m (6138/K); UKA: Mandege F. St. 1200 m (6744/,A); SHL Mufindi 1900 m (c. Paget-Wilkes 765); POR: Ngozi Lake crater rim E 2000—2250 m 6329/BJ, 6330/T, 6331/K, L); RUN: E of Rungwe village, 1500 m (6768/A); Mt. Rungwe E crater rim 2500—2600 m (6504/K); Pantropical species, very widespread in tropical Africa.

148. **Fissidens atroviridis** Besch. Ann. Sc. Nat. Bot. ser. 7, 2: 86 (1885)
Syn. nov.: *Fissidens cellulosus* Mitt., J. Linn. Soc. Bot. 22: 319 (1886)
On irrigated rocks, travertino banks, rotting wood or on soil. *EUS: Near Chemka village, 550—600 m (6382/D, E, F); *ULU: Kimboza F.R. 300 m (6188/AG); Valley behind Morogoro TTC, 700 m (c. P s.n.); Morningside 1420 m (6414/H, K); USG: Great Ruaha River gorge SW of Mikumi, 480 m (6314/F); *Z: 13 km E of Lusaka, 1300 m (6609/G, B p.p.); det. B. Palaeotropic species, from East Africa to tropical Asia and New Guinea.

149. **Fissidens bonnotii** Bizot Syn.: *Fissidens subelimbatus* P. Varde var. *crispus* P. Varde (cf. Bizot Rev. Bryol. Lichén. 42: 852, 1976) — Lowland and submontane forest species, ct, te, ru. *SPA: WNW of Kisiwani village, E slope of Mt. Kwizu, 1000 m (6716/H); Foothills of EUS: Tongwe hill SSW of Muheza, 400 m (6517/F); *NGU: Near Mhonda Mission, 500—1100 m (6396/E, 6434/A); *ULU: Valley behind Morogoro TTC, 700 m (6737/J); Lupanga WNW above Kibwe village, 1200 m (6546/C); Mangala F.R. 400—500 m (6415/B); W of Tawa village near Kibogwa 700 m (6417/A); near Kinole sawmill 800—950 m (6171/B); *USG: West Kilombero Scarp F.R. near Kidatu 600—700 m (6143/J;) det. B. Previously known only from the type locality in Gabon: Mocandi.

150. **Fissidens borgenii** Hamp. var. **obtusifolius** Broth. et Dix. — On shady rocks in lowland and in submontane forests. *ULU: Kimboza F.R. 300 m (6188/AC) *SPA: Mt. Kwizu E, above Kisiwani, 900 m (6716/L); det. B. Previously known only f;om Natal.

151. **Fissidens simii** Schelpe in Magill and Schelpe 1979: 5. Syn.: *F. aristatus* Sim 1926 non Broth. 1916. — Terricolous, on roadside bank. *ULU: Chenzema Mission, 1700 m (8612/DA); det. B. Previously known only from Natal.

152. **Fissidens breutelii** Schimp. — On the ground of *Erica-Hagenia-Senecio* forest. *K IL Above Mandara Hut, 2800 m (6245/G); det. B. Previously known only from Cape.

153. **Fissidens bukobensis** Broth. — Submontane rain forests, ru, te. *ULU: Near Kinole sawmill, 900 m (6189/F); Manga E 1200 m (6225/B); Lupanga SW above Kileka village 1450—1750 m (6831/A); Bondwa N 1650 m (6898/B); det. B. Known from Tanzania, Bukoba and from Uganda.

154. **Fissidens calabariae** C. Müll. — Terricolous in montane forest. *ULU: Mwere v., 1600 m (6257/D); det. B. New for East Africa, known only from Guinea, Nigeria and Gabon.

155. **Fissidens comorensis** C. Müll. — On rocks and on bark in submontane and montane forests. *KIL: Mawingo Estate bear Mweka, 1350 m (6349/AB, AC); *NGU: near Mhonda Mission, 800—1000 m (6400/C); *ULU: Mt. Kinazi WNW 1400—1650 m (6289/R); Mwere v. 1500—1600 m (6257/A); Maunga v. above Mzinga village, 1500 m (6263/A); det. B. Tropical African species known from Nigeria, Madagascar and from the Mascarenes.

156. **Fissidens crassipes** B. S. G. var. **philiberti** Besch. Syn.: *F. dubiosus* Dix., *F. warnstorfii* Fleisch. — On irrigated rocks and on hanging aerial roots in a small waterfall at the N, side of Great Ruaha River gorge ("Stiegler's gorge"), SW of Mikumi, 480 m (6314/B, C D, E); det. B. Europe, the Middle East, North, tropical and South Africa, uncommon.

157. **Fissidens crateris** Dix. — Terricolous, sometimes corticolous or rupicolous in montane forests, forest edges, roadsides, tea plantations on even in gardens. *WUS: Mazumbai U.F.R. 1500 m (6370/BF p.p.); *MER: Kitoto 2450—2650 m (6340/AC, AD, AF); Malama forest 1800 m (6338/AA); *ULU: Maunga v. above Mzinga, 1500 m (6263/B); Morningside 1350 m (6267/A); Mgeta — Chenzema road, 1340—1550 m (6391/C, 6392/B p.p.); Chenzema Mission 1700 m (6812/DC); Lukwangule Plateau E 2350 m (6828/SA); *UKA: Mamiwa West F. R. S 1870 m (6862/B); Mt. Ikwamba 1720—1850 m (6865/P, Z); 1 km SW of Mandege F. St. 1520 m (6869/C, D); *SHL: Mufindi Escarpment, near Kilima Tea Factory, 1900 m (6321/O); near the Fishing Camp, 1730 m (6322/P); Mbeya township, in the garden of Mbeya hotel, 1650 m (6325/E, F); *POR: Ngozi crater E 2100—2250 m (6329/BL, 6330/U, V); *RUN: Mt. Rungwe N, 2300 m (6334/AF); det. B. EA montane species, known from E Zaire, Uganda and Kenya, at alt. 1400—3500 m.

158. **Fissidens cryptoneuron** P. Varde — Corticolous in wet riverine forest. *Z: Victoria Falls, Palm Grove, 800 m (6614/A); det. B. Tropical African, new for continental East Africa.

159. **Fissidens dartnyi** Schpr. — Lowland and submontane woodland, dry and wet forest, on soil, rocks and on *Cyathea* stem. T: Pugu hills near Kisarawe, 250 m (6038/A); *ULU: Morogoro, Agricultural Faculty Campus, 600 m (6001/A); Mwere v. 1500 m (6220/A); det. B. Tropical African species, new to continental East Africa.

160. **Fissidens diaphanodonta** (P. Varde) Bizot **nov. comb.**

Basionym: *Moenkemeyera diaphanodonta* P. Varde, Rev. Bryol. Lichén. 20: 4 (1951). Corticolous in submontane rain forest. *EUS: Amani, 800—870 m (6293/B, 6378/w); det. B. New for East Africa, previously known only from the type locality: Bukoko in the Republic of Central Africa.

161. **Fissidens enervis** Sim, Trans. R. Soc. S. Afr. 15: 187 (1926).

Syn. nov.: *Fissidens molliculus* P. Varde, Rev. Bryol. Lichénol. 7: 227, Fig. 1A—C (1935).

On stony roadcut surface. *ULU: S of Mgeta village, along the Chenzema road, 1340—1550 m (6391/D, 6392/B p.p.); det. B. Republic of Central Africa and Natal, new for East Africa.

161/A **Fissidens enervis** Sim ssp. **hedbergii** (P. Varde) Bizot **nov. comb.**

Basionym: *Fissidens hedbergii* P. Varde, Ark. Bot., Ser. 2, 3: 129 (1955). *Fissidens hedbergii* is connected by intermediate forms with *F. enervis* and seems to be only a subspecies of the latter, isolated in the montane forest belt of East Africa, previously known from Mt. Kilimanjaro. — Terricolous in montane forests. *WUS: Mazumbai U.F.R. 1500—1800 m (6370/BC,

6372/CD); *ULU: Mwere v. 1600 m (6257/C); Mzinga v. 1400 m (6266/H); Bondwa NW 1500 m (6303/F); Kikododo above Bunduki, 1600 m (6463/M); Palata 1850 m (6852/C); Morningside 1420 m (6414/F, G); Chenzema Mission 1700 m (6812/D); Lukwangula Plateau E 2250—2350 m (6828/S); *UKA: Mt. Ikwamba NW 1700—1875 m (6865/X); Mandege SW 1520 m (6869/FB); *SHL: Mufindi, lake shore 1800 m (6324/J); *POR: Lake Ngozi crater E 2100 m (6330/Z); *RUN: Mt. Rungwe SW 1800 m (6777/AE, AF); *Z: 13 km E of Lusaka, 1300 m (6609/B); det. B.

162. **Fissidens fontanus** (Pyl.) Steud. Syn. *Octodiceras julianum* (Savi) Brid. — Z: Victoria Falls, Palm Grove, 800 m, on irrigated stones in a streamlet (6614/E); det. B. Subcosmopolite, rare in tropics.
163. **Fissidens gibbonii** Bizot! — Terricolous, rupicolous, sometimes on rotting wood or on Cyathea stem in submontane or in montane forests, very seldom below 1000 m. *KIL: Below Machame Hospital, 1500 m (6361/B, D); between Marangu and Old Moshi, 1700 m (6368/AB, AC, AD, AE, AF), Mweka Route 2150 m (6342/AF, AG, AH, 6344/BC); Umbwe Route 1700—1900 m (6351/AG, AH); Marangu Route 2700 m (6243/N, 6244/D); *WUS: Mazumbai U.F.R. 1500—1880 m (6370/BE, BF, BK, BM, 6372/CC, 6374/BA, BE); between Magamba and Mabweni, 1850 m (6205/A p.p.); ULU: N, NE, E slopes 1650—2000 m (6387/O, 6573/G, 6848/G, H); above Simbini village, 1400—1500 m (6418/T, AH); NW gorge of Kinazi 1400—1650 m (6289/K, P); Kinazi peak N 1950 m (6838/D, E); Mzinga v. 1400 m (6266/K); Lupanga NW, SW 1500—1900 m (6286/R p.p., 6284/U); Mt. Kifuru E 1580 m (6905/K); *UKA: Mandege F. St. — Uponela road 1600 m (c. MABBERLEY 1358/A); Mamiwa East peak 2200 m (c. MABBERLEY 1392); *USG: Gologolo Mts., Mwanihana F.R. near Sonjo, 300 m 6144/R; det. B. East African montane species.
164. **Fissidens gladiolus** Mitt. Syn.: *Nanobryum gladiolum* (Mitt.) Biz. — Terricolous in dry evergreen submontane forest. Kitulanghalo F.R. ENE of Morogoro, SE 770 m 6856/**w**; det. B. Tropical African, known from Nigeria to Uganda.
165. **Fissidens gomae** P. Varde et Leroy — From lowland forests to altimontane bamboo stands, on travertino, soil and on bark. NGO: Oldonyo Oldeani NNW 2700—3000 m 6921/B; *ULU: Kimboza F.R. 280 m (6024/B); *UKA: 1 km SW of Mandege F. St., 1500 m (6868/B); det. B. Known from East African volcances between 1000—2500 m.
166. **Fissidens haakonii** Broth. et Bryhn. — On rocks or on soil of forests and of relatively dry woodlands. Pande F.R. 15 miles WNW of Dar es Salaam, 150 m (6161/A); *ULU: Kimboza F.R. 300 m (6188/AF); Morogoro, Agricultural Faculty Campus, 630 m (6001/B); Tegetero Mission 975 m (6424/X); Kinole sawmill 900—950 m (6172/E); above Simbini village 1400—1500 m (6418/T); Mt. Kinazi gorge 1400—1650 m (6289/N); Lupanga SW 1700—1900 m (6285/S p.p.); det. B. SE African: Rhodesia, Zululand.
167. **Fissidens helictocaulos** C. Müll. — On relatively dry rocks, sometimes on brick walls, concret pillars or on soil in forests or in rocky gorges and other open places. *KIL: Marangu, Kibo Hotel garden 1450 m (6207/B, D); Kikafu gorge near Kibohehe and near Kalali, 1000—1250 m (6362/C, 6348/B); *EUS: Amani 900 m (6095/C); *ULU: Morningside 1250 m (6005/S, **w**); *UZU: Kitonga gorge, 980 m (6316/**w**, R, S)- *POR: Lake Ngozi crater rim 2200 m (6329/BP); *Z: 13 km E of Lusaka, 1300 m (6609/A, C, D, F, H); 135 km E of Lusaka between Unda-Unda and Rufunza, 1300 m (c. KORNAŚ B-11/B); det. B. Known from Erythrea and from Rhodesia.
168. **Fissidens holstii** Broth. — On rocks and on the soil of submontane or montane rain forests. WUS: Mazumbai U.F.R. 1500 m (6370/BH, BL); *NGU: Kwamanga, S of Mhonda

Mission, 1400 m (6398/C); between Mhonda and Kombola villages in the Duale v. 600—1200 m (6435/E, 6436/F); Mafulumula coll 1650—1800 m (6438/O, P, w); bamboo forest S of Maskat 1850 m (6442/A); *ULU: Kinole sawmill 900—1000 m (6166/E, 6171/A); Mwere v. 1500—1600 m (6174/B); *UKA: Mt. Kifigo 1600—1760 m (6591/G); Mandege F. St. 1540 m (6737/H); det. B. Known from Liberia, Gabon and from the Usambara Mts.

169. **Fissidens hoeegii** P. Varde — On rocks and soil of submontane-montane forests. *KIL: Marangu, Kinukamari falls, 1500 m (6237/B, E, F, G); *ULU: Morningside, 1240 m (6571/A); *UKA: Mt. Mnyera NE 1500 m (6864/E); det. B. Previously known only from Natal, new for East Africa.

170. **Fissidens horizonticarpus** C. Müll. — Lowland and submontane forests, ru, te. *ULU: Morogoro, valley behind TTC, 1000 m (6046/U, T); Kimboza F.R. 300 m (6216/M); det. B. Previously known only from West Africa.

171. **Fissidens hymenodon** Besch. — Lowland and submontane woodland and forests, ru, te, li. *NGU: near Makuya, 600 m, W of Mhonda Mission, 550—800 m (6036/A); *ULU: Kitulanghalo F.R. ENE of Morogoro, SE 460—730 m (6856/G, T); Mt. Kinazi gorge 1400—1600 m (6289/P p.p.); det. B. Known only from Madagascar, new for East Africa.

172. **Fissidens idanreensis** P. Varde — Submontane forests, ru, ct. EUS: Amani NW, 900 m (6380/H); *ULU: Kikundi, 900 m (6428/B); *Z: Victoria Falls, Knife edge, 870 m (6613/A); det. B. Tropical African species, uncommon.

173. **Fissidens jonesii** Bizot! — Exclusively on *Cyathea* stems (or seldom epiphyllous) in montane forests and in elfin woodlands. *NGU: Above Kwamanga, 1100—1400 m (6397/C); *WUS: "Kambo" in Mazumbai U.F.R., 1620 m (6374/BE); ULU: Bondwa E, NE, and top, 1600—2030 m (6181/CE, 6120/B, 6260/A, 6537/J, 6387/N, 6403/AA); Lupanga S 1900—2000 m (6287/AT); Mwere v. 1550 m (6891/J); *UKA: Mt. Ikwamba N 1875—1920 m (6866/O); det. B. It seems to be an endemic species of the wet montane rain forests of old cristalline massifs in Eastern Tanzania.

178. **Fissidens kegelianus** C. Müll. Syn. Musc. 1: 49 (1848).

Syn. nov.: *Fissidens monostictus* Broth. et P. Varde, Bull. Soc. Bot. France 72: 791 (1925).

Terricolous in woodland and relatively dry forest areas. *KIL: Mawingo Estate near Mweka, 1350 m (6349/AE); *ULU: above Morogoro town, 750 m (6401/AG p.p.); det. B. Known in tropical America from Southern USA to Northern South America; in Africa: Gabon and Republic of Central Africa, new for East Africa.

179. **Fissidens latifolius** Dix. — Terricolous, sometimes on rocks in *Brachystegia* and other dry woodland types. *ULU: below Morningside, 1150 m (6735/B); *KIB: near Kikombo above Mpwapwa, 1200—1500 m (6563/N); *Z: 13 km E of Lusaka, 1300 m (6609/E); 10 km ENE of Choma, 1000 m (6618/A, B, C); 125 km E of Lusaka, between Unda-Unda and Rufunza, 1100 m (6620/C); det. B. SE African, from Aberdare range to Rhodesia.

180. **Fissidens lacouturei** Thér. in Ren. — Rupicolous in submontane woodland. *ULU: Morningside, 1300 m (6429/C); Mt. Mindu E 600 m (6541/K); det. B. New for continental Africa, previously known only from Madagascar.

181. **Fissidens leucocinctus** Hpe — On irrigated basaltic rocks. *KIL: Marangu Route 1900 m (6208/N); det. B. Previously known only from Cameroun and from the East African Islands.

182. **Fissidens leucocaulis** C. Müll. ex Biz. — Rupicolous in relatively dry lowland and submontane forests. *Pugu Hills near Kisarawe, 200 m (6039/A); *ULU: Lupanga N 1000 m (6018/G); det. B. Previously known only from West Africa.

183. **Fissidens longelimbatus** Broth. — Montane forests, ru, ct, te. *KEN: Castle F. St. 2000 m (6603/A); KIL: Mweka Route 1800—2100 m (6211/A, 6343/L p.p., 6342/AK, AL); det. B. Known only from the East African volcanoes.

184. **Fissidens longidens** Bizot! — Corticolous in submontane rain forests. *KIL: Mua falls near Maua village, 1600 m (6368/AA); EUS: Amani, Hunga valley, 880 m (6514/C, D); *NGU: above Mhonda Mission, 800—1000 m (6400/A); near Kombola village, 900—1200 m (6436/E); above Kwamanga village, 1400 m (6398/B); *ULU: Manga E 1100 m (6223/A); Midhani NNE of Kinole village, 880 m (6881/M, L), near Kinole sawmill, 1100 m (6874/F); det. B. East African montane species.

185. **Fissidens mac-owanianus** C. Müll. — Montane forests and roadsides, ru, te. *ULU: Chenzema Mission 1700 m (6812/DD); *UKA: Mt. Ikwamba NW 1700—1775 m (6865/D, E, T); det. B. Previously known only from Cape. It is not conspecific with *Fissidens rufescens* Hornsch. (B).

186. **Fissidens malaco-bryoides** C. Müll. — Corticolous in montane forest. *NGU: Mafulumula W 1700—1800 m (6441/C); det. B. S + E African, from Nairobi to Cape.

187. **Fissidens marthae** Card. — Submontane forests, ct, ru, te. *EUS: Ngurue v. E of Chemka village, 500—600 m (6516/K); Amani 900 m (6107/C); *ULU: Morningside 1050 m (6267/A); Bondwa E 1600 m (6181/CF); det. B. New for East Africa, previously known only from Senegambia to Zaire.

188. **Fissidens metzgeria** (C. Müll.) Broth. — Terricolous in montane forest. *UKA: Mandege F. St. SW 1520 m (6869/FA); det. B. Previously known only in West Africa: Monbouttou.

189. **Fissidens micro-androgynus** Dix. — Terricolous in dry forests. *KIB: Riverine forest near Kikombo N of Mpwapwa, 1200 m (6564/A); *Z: 13 km E of Lusaka, 1300 m (6609/J); det. B. Previously known only from Rhodesia: Bulawayo.

190. **Fissidens nitens** Rehm. ex Salm. s.l. — Montane forests, elfin woodland, et, ru, te. *KIL: Mweka Route 1800—2000 m (6342/AJ, 6343/J); Kimefu v. above Nkweseko, 1850 m (6360/w); *NGU: W of Mhonda Mission, 800—1000 m (6400/D); *ULU: Lupanga NW 1400 m (6065/M); SW 1700—1900 m (6285/P); Lupanga crest 2050 m (6551/B); Bondwa N 1450—1700 m (6119/D, 6307/R, 6430/D); *Fissidens nitens*, as treated here, is a species complex including *F. letestui*, *F. schnellii*, *F. mariei* and *F. porrectus*, and needs further study. In the above sense its distribution is tropical and S African. Det. and annotated by B.

191. **Fissidens opacifolius** Mitt. — Terricolous on roadside banks at relatively dry, open places. *Dar es Salaam University Campus, 40 m (c. WINGFIELD 2770); *ULU: Morningside — Schlesien Mission 1240 m (6311/S, T, U, 6575/A, B, C); det. B. Tropical African, known from Nigeria and from Usambara Mts. and from Natal (?).

192. **Fissidens ovatus** Brid. — Submontane and montane forests and subalpine ericaceous woodlands, on shady rocks, often on sprayed rocks of waterfalls, sometimes on bark or on soil. *KIL: Marangu Route 1900 m (6208/M); Mawingo Estate near Mweka village, 1350 m (6349/AC p.p.); Umbwe Route, near IInd Bivouac, 3360 m (6932/A); *EUS: Amani 850 m (6090/D); *ULU: Morningside 1250 m (6004/E); behind Morogoro TTC 650—700 m (6016/C, 6063/A, 6046/L, N, 6723/K); Mzinga v. 1500 m (6290/AB); Manga E 1100 m (6223/B, C); Msanga falls above Mzinga village 1150 m (6110/F, G, L); Kisimbi falls 700 m (6276/H); Lupanga crest WNW 1900—2050 m (6550/G; Mzuazi v. NNE of Kinole, 845 m (6882/HA); *NGU: Mnembule — Maskat, Mafulumula W, 1700—1800 m (6441/D); *SHL: Mufindi Escarpment near the artificial lake, 1720 m (6323/X, Y); Lupeme Estate 1750 m (6318/AG); *POR: Lake Ngozi crater rim 2200—2250 m (6329/BD, BH, BK, BN); *RUN: Mt. Rungwe N 2300 m, ENE 2400—2500 m, SW 2100—2300 m (6334/AE, 6503/M, N, O, 6761/B, 6778/A, 6763/A, 6764/B); *Z: Victoria Falls, Knife Edge, 870 m (6613/A, B, C, D); Kundulila Falls SE of Kanona, 1430 m (6623/B); det. B.

— f. **cymatophyllus** (C. Müll.) *ULU: Bondwa N 1450 m (6854/Y); Mwere v. 1500 m (6853/F); Lukwangule Plateau W 2200 m (6813/A); Hululu Falls SSE of Bunduki, 1460—1560 m (6900/H); det. B.

— var. **ochroloma** Ren. et Card. — *ULU: Midhani, NE of Kinole, 860 m (6879/K); Palata N, 1670 m (6850/H); *KIL: Kimefu v. above Nkweseko, 1850 m (6360/R); det. B. Distribution of the whole species: Acores, S Africa, E Africa, Comores, Madagascar and Mascarenes.

193. **Fissidens parkii** Mitt., Trans. Linn. Soc. London 23: 56 (1860)
Syn. nov.: *Fissidens microcarpus* Mitt., J. Linn. Soc. Bot. 7: 162 (1863)
Fissidens konkourae Par. et Broth. Rev. Bryol. 31: 84 (1904)
Fissidens guineensis Par. et Broth. Mém. Soc. Bot. France 14: 11 (1908)
On shady streamside rocks in lowland rain forest. *EUS: Sigi v., 500 m (6294/B, D); det. B. Previously known only from West Africa, from Guinea to Cameroon.
194. **Fissidens parvilimbatus** Sim — *UKA: Mamiwa West S 1870 m, on shady rocks (6862/A); det. B. Previously known only from Natal, new for East Africa.
195. **Fissidens pechuelii** (C. Müll.) Jaeg. — On half shady roadside rocks. *ULU: Morningside, 1250 m (6604/F); det. B. Previously known only from the Republic of Central Africa and from Zaire, new for East Africa.
196. **Fissidens pictus** Bizot! — On shady, wet rocks or on soil of submontane forests. ULU: Mgeta v. S of Bunduki F. St. 1275 m (6907/D); near Kinole sawmill, 1100 m (6874/M); det. B. Known only from the East Usambara and from the Uluguru Mts.
197. **Fissidens pierrotii** Bizot. — Corticolous in dry evergreen coastal forest. Pugu Hills WSW of Dar es Salaam, 250 m (6038/C); det. B. Previously known only from the Republic of Central Africa: Oubangui.
198. **Fissidens planifrons** Besch. Syn.: *F. vulcanicus* Ren. et Card. Rupicolous in lowland rain forest. *EUS: Sigi, 500 m (6294/C); Ngurue v. E of Chemka village, 500—600 m (6516/J); det. B. East African — Lemurian species, previously known only from Madagascar and Mayotte I.

— **Fissidens pseudoeenii** Biz. et Dury!, in Bizot, Rev. Bryol. Lichénol. 40: 134 (1974); validated by Pócs, Fol. Hist. nat. Mus. Matrensis 4: 30 (1977). The type locality is erroneously given in the original publication, as Uluguru Mts. The type specimen was collected in the UKAguru Mts. by Pócs, Mabberley and Salehe, No. 6743/D. Annotation by P.

199. **Fissidens purpureocaulis** C. Müll. — Lowland, submontane and montane forests, elfin woodland, ct, ru, te, li and on *Cyathea* stem. *KIL: Mweka Route, 1800—2150 m (6211/C, 6344/BD, 6343/K, 6360/P); Mawingo Estate near Mweka, 1350 m (6349/AC); Umbwe Route 2850 m (6788/AG, AJ, AK); Marangu Route 1900—2200 m (6364/N); *WUS: Mazumbai U.F.R. 1750—1880 m (6372/CB, 6373/O); Kambo near Mazumbai, 1620 m (6374/BC); *EUS: Amani 920 m (6377/M); *NGU: Mt. Mafulumula E above Mnembule village, 1850 m (6439/H); *ULU: Kimboza F.R. 300 m (6216/A, B); near Kinole sawmill (6189/H); Manga E 1250 m (6225/C); Mt. Kinazi 1400—1650 m (6289/**w**, S, U); Mzinga v. 1400—1600 m (6290/AA p.p.); Mwere v. 1600 m (6180/E); Gambaula F.R. 400 m (6420/H); Tegetero Mission, 975 m (6424/M); Simbini E 1400—1500 m (6418/AB); Morogoro, Bahati Camp, 600 m (6561/B); Palata W 1520 m (6849/D); Bondwa 1700—2100 m (6307/L, 6404/AF); Lupanga SW 1700—1900 m (6285/**w** p.p.); Magari peak 2000—2100 m (6297/H); *UKA: Mnyera ridge SSW 1950 m (6742/F); *KIB: main summit above Mpwapwa, 1900—2000 m (6569/F); *POR: Lake Ngozi Crater rim 2250 m (6329/BE, BF, BG, BM, Bw); det. B. Tropical African species, previously known only from Sao-Tomé and Cameroon, new for East Africa.

200. **Fissidens reflexus** Hpe — On rocky roadcut surface. *ULU: Morningside, 1300 m (6203/L p.p.); det. B. Previously known only from Madagascar, new for continental Africa.

201. **Fissidens rivicola** Broth. et P. Varde — On travertino and other streamside rocks or on the earth of lowland and submontane forests. *WUS: Mazumbai U.F.R. 1500 m (6370/BD); *ULU: Milawalila F.R. near Tawa village above the Mwuha stream, 400 m (6416/H); Kimboza F.R. 300 m (6188/AH); det. B. Previously known only from the Republic of Central Africa and from Gabon, new for East Africa.

202. **Fissidens rufescens** Hornsch. — On the earth of coffee plantations, gardens, on bricks of old buildings. KIL: Lyamungu Coffee Research Station, 1260 m (6195/A, B, D, E); Marangu, Kibo Hotel garden, 1450 (6207/A); WUS: Lushoto, Lawns Hotel garden, 1400 m (6204/D); *ULU: Morningside, 1300—1420 m (6203/J, K, 6420/G p.p.); det. B. EA and SA, uncommon.

203. **Fissidens sciophyllus** Mitt. Trans. Linn. Soc. London 23: 55 (1860)

Syn. nov.: *Fissidens gumangensis* (C. Müll.) Par. Index Bryol. II: 471 (1875)

Basionym.: *Conomitrium gumangense* C. Müll. Linnaea 39: 366 (1875)

Rupicolous and terricolous in dry woodland, *Vellozia* bush, on limestone or other rocks, roadsides, sometimes on bark in dry evergreen forests. *EUS: near Chemka village, 500—600 m (6382/D, 6516/H); *NGU: near Mhonda Mission, 600—700 m (6433/C, D, 6399/E); *SPA: Mt. Kwizu E, near Kisiwani, 875 m (6716/C, D, E); *Dar es Salaam, University Campus, 40 m (c. Wingfield 2727); ULU: Kitulanghalo F.R. 35 km NE of Morogoro, 750 m (6856/J, AB); Kimboza F.R. 300—450 m (6729/B, C, 6800/J, K, 6801/K); Mangala F.R. 500 m (6415/A); near Matombo village 350 m (6062/A); Morogoro River v. 550 m (6014, 6003); Valley behind Morogoro TTC, 650—1000 m (6016/J, 6046/T); Teak plantations between Morogoro and Mgolole, 550 m (6115/A, B); near Mkuyuni village, 300 m (6021/A); Kinole sawmill 900 m (6189/G); Lupanga N 1000 m (6018/F, 6046/P p.p., T); Bahati Camp near Morogoro, 600 m (6561/R, S); Mt. Mindu E 600 m (6542/H, J); Tegetero Mission 975 m (6424/Y); Hululu Falls above Bunduki, 1480 m (6902/C); *KIB: Mpwapwa — Kikombo 1200 m (6564/B); *Z: 13 km E of Lusaka, *Euphorbia candelabrum* woodland, 1300 m (6611/A); 125 km E of Lusaka, between Unda-Unda and Rufunza, 1200 m (6621/G, H); det. B. Tropical African species, previously known from Nigeria, Chad and from the Republic of Central Africa, new for East Africa.

204. **Fissidens smilioides** P. Varde — On rocky roadcut surface and on soil of coffee plantation. *KIL: Lyamungu, 1260 m (6195/D p.p.); *ULU: Morningside, 1250 m (6004/F p.p.); det. B. Previously known only from the type locality in the Republic of Central Africa, Oubangui.

205. **Fissidens spinosolimbatus** Biz. et Dury! — In *Arundinaria alpina* bamboo stand, terricolous. *KEN: Kamweti track, 2400—2700 m (6601/ZC); det. B. Afroalpine species, previously known only from the type locality on Mt. Kilimanjaro at 2900 m altitude.

206. **Fissidens subambiguus** Biz. et Dury! — On termite mound in *Brachystegia* woodland. ULU: Mt. Mindu S 950 m (6491/D); det. B. Known only from the type locality: Kibungo Mission area in the Uluguru Mts.

207. **Fissidens subcongolensis** Bizot et Dury! — On shady rocks in montane forest. *KIL: Mnangue v. above Mweka, 1900 m (6343/J p.p.); det. B. Previously known only from the type locality in the Ulguru Mts.

208. **Fissidens subexasperatus** Bizot! — Corticolous in montane forest. *SHL: Mufindi Escarpment, Lupeme Tea Estate, 1750 m (6318/T); det. B. Previously known only from the type locality: Uluguru Mts.

209. **Fissidens subobtusatus** C. Müll. — Corticolous or on *Vellozia* stem in forests and in dry woodlands. *SPA: Mt. Kwizu E above Kisiwani, 900 m (6716/G); *ULU: Mt. Mindu SE 570 m (6488/D, 6840/B, C); Nguru ya Ndege E 750 m (6480/B); *USA: Gologolo Mts., F,

near Sanje Falls, 300 m (6044/P); *Z: Muchinga Escarpment, Mt. Mukowonshi, 45 km NNE of Mpika, 1800—1840 m (6629/H, J); Victoria Falls, Palm Grove, 800 m (6614/A); det. B. SE African, previously known from Transvaal.

210. **Fissidens sylvaticus** Griff. Cal. J. Nat. Hist. 2: 507 (1842)

Syn. nov.: *Fissidens amblyophyllus* C. Müll., Hedwigia 38: 57 (1899)

Rupicolous, sometimes on earth or on concret pillars, in lowland and in submontane forests. *SPA: Mt. Kwizu E, 1000 m (6716/K); *EUS: Amani 870 m (6090/A); near Kwamkoro, 960 m (6379/D); Ngurue v. E of Chemka, 500—600 m (6516/L, H p.p.); *KAN: 650 m (6136/N, O); *NGU: near Mhonda Mission, 800—1000 m (6400/B); above Kwamanga village, 1100—1400 m (6397/A, B); *ULU: Mkungwe F.R., E of Kikundi, 800—1100 m (6218/A); Valley behind Morogoro TTC, 1000 m (6046/P, w, R); Bondwa N 1450 m (6184/B); *USA: Gologolo Mts. near Sonjo, 300 m (6144/w, S); *Z: 13 km E of Lusaka, 1300 m (6609/G p.p.); det. B. Widespread in tropical and in S Africa, in tropical Asia and in Oceania.

211. **Fissidens ugandae** Dix. et P. Varde — Terricolous in a small, mist effected montane forest patch. *KIB: mean peak above Mwapwa, 1900—2000 m (6569/G); det. B. Previously known only from Uganda: Musanda.

212. **Fissidens ulna** (C. Müll.) Par. — Terricolous in *Brachystegia* woodland. *ULU: Mt. Mindu E 720—870 m (6841/A, C, D); det. B. Widespread from Guinea to the Republic of Central Africa, new for East Africa.

213. **Fissidens usambaricus** Broth. — Terricolous in submontane forests. WUS: Mazumbai U.F.R. 1500 m (6370/BG); *NGU: W of Mhonda Mission, 550—800 m (6399/A); det. B. Tropical African, uncommon.

214. **Fissidens ventroalaris** Card. — Terricolous in *Brachystegia* and other woodland. *ULU: above Morogoro town, 750 m (6401/AG); Morningside, 1240 m (6311/R, 6414/J, L); *Muchinga Escarpment, Mt. Mulilidwa NE of Shiwa Ngandu, 1500 m (6627/A, B); det. B. SEA-Lemurian element, previously known only from Madagascar.

215. **Fissidens vesiculosus** Demaret et Leroy — On roadsides, old bricks in garden and on soil of coffee plantation. KIL: Marangu, Kibo Hotel, 1450 m (6207/C); Lyamungu Coffee Research St., 1260 m (6195/C); *ULU: Morningside, 1240 m (6414/H); det. B. EA montane species known from Kivu Nat. Park, Ruwenzori, Mt. Meru and Kilimanjaro.

216. **Fissidens vogelianus** Mitt. — Lowland, and montane forests, te, ct, and on *Cyathea* stem. *KIL: Mweka Route, 1800—1900 m (6211/B); *WUS: Kombo near Mazumbai, 1620 m (6374/BD); *EUS: near Chemka, 600 m (6382/D, E, 6516/H p.p.); *NGU: Duale v. near Mhonda Mission, 550—700 m (6434/A, 6433/C, D p.p.); det. B. Known from West Africa and from Madagascar and the Mascarenes, new for East Africa.

217. **Fissidens welwitschii** Dub. — Lowland and submontane forests, te, ru. *NGU: Mhonda Mission — Kwamanga, 700—1100 m (6396/F; *ULU: Milawalila F.R. in Mwuha v., 400 m (6416/J); det. B. Known only from Angola, new for East Africa.

Archidiaceae

218. **Archidium africanum** Mitt. — On wet earth. *Dar es Salaam, 30 m (c. Wingfield 2766/A); det. B. Previously known only from the Usagara Mts.

Ditrichaceae

219. **Ditrichum difficile** (Dub.) Fleisch. — Terricolous or rupicolous in montane forests. *KIL: Marangu Route 2650 m (6239/H); Umbwe Route 2850—2900 m (6788/R, BE, CA); Upper Kikafu, 1600—1800 m (6346/H); *ULU: Magari peak, 2000—2100 m (6297/L); Lukwangule Plateau E, near Mgeta falls, 2350 m (6822/W, AV, AY, AZ); *WUS: Mazumbai

U.F.R. 1500 m (6370/AU); det. B. Palaeotropic species, widespread in SE Asia, in the Mascarenes and in South Africa. There is an important character to distinguish it from the *Dicranella* species similar in appearence: the very thick midrib formed by 5—6 cell rows in transversal leaf section. Annotation by B. See also EAB I.

220. **Ceratodon purpureus** (Hedw.) Brid. — KIL: Mweka Base Hut, 3000 m (6720/S); Umbwe Route, near the Ist and near the IInd Bivouacs, 2900, 3600 m (6788/BH, 6792/G); RUN: Mt. Rungwe W 2660 m (6506/F); det. B. Cosmopolite, altimontane in tropical Africa, on rocky or on earthy ground, sometimes on rotting wood.

Dicranaceae

221. **Trematodon mayottensis** Besch. — Earth gullies eroded in landslide surface. *ULU: E of Mgeta, 960 m (6389/A); det. B. SE African — Lemurian species, known in Rhodesia, Natal and from Mayotte I.

222. **Trematodon schroederi** Broth. Syn.: *T. victoriae* Dus. — In erosion gullies and on rocks along the Mgeta — Chenzema road, 1340—1500 m (6390/B, 6392/E); det. B. Tropical African species, known from Cameroon and from the Usambara Mts.

223. **Anisothecium ugandae** P. Varde — Montane forest rich in *Arundinaria alpina* and streambed in giant groundsel (*Senecio johnstonii*) stands, on irrigated rocks. *KIL: near Barranco Hut, 3850 m (6794/J); *ULU: Mgeta v., 2215 m (6829/O); det. B. Afroalpine element, previously known only from the Muhawura at 3350 m altitude.

224. **Aongstroemia vulcanica** (Brid.) C. Müll. — On wet, shady rock in montane forest or at edge of elfin woodland. *ULU: Lupanga crest, NW 2050 m (6551/F); E edge of Lukwangule Plateau, Mgeta waterfalls, 2350 m (6822/AV); det. B. Known from South Africa, Madagascar, Réunion and from tropical America.

225. **Dicranella usambarica** P. Varde — Terricolous, often on roadcut surface, in montane forests or in tea plantations. *KIL: Kinukamari Falls near Marangu, 1500 m (6237/M); Marangu Route 2200 m (6365/AA); *ULU: Bondwa peak 1950 m (6011/P); *KEN: Kamweti track 2400—2700 m (6601/AU); *WUS: Magamba — Mabweni, 1850 m (6205/E); *EUS: Kwamkoro Tea Estate, 900 m (6945/A); det. B. The species is very close to, or maybe a reduced form of *Dicranella subsubulata* (Hampe) Jaeg. EAB I No. 181 should be referred under *D. usambarica*, if the two species are treated separately. *D. usambarica* is known only from the type locality near Amani, in the East Usambara Mts. Annotation by B.

226. **Campylopodium euphorocladum** (C. Müll.) Besch. — On the soil of bamboo (*Arundinaria alpina*) stands. *KEN: Kamweti track 2400 - 2700 m (6601/ZB); det. B. Palaeotropic species, in Africa known from E Zaire, Uganda, Aberdare and Kilimanjaro Mts.

227. **Microcampylopus** cf. **perpusillus** (Mitt.) Broth. ex Par. — Terricolous, on white sandy soil of dry woodland. *Z: Mt. Mulilidwa NE of Shiva-Ngandu, 1500 m (6627/R); det. B. Tropical African, from Nigeria to Transvaal.

228. **Campylopus flageyi** Ren. et Card. — On wet, shady rocks in montane forest. *ULU: Lupanga crest 2050 m, SW (6551/G); det. B. New for East Africa, previously known only from Madagascar.

229. **Campylopus fragilis** (Dicks.) B. S. G. — On bark of a sole *Agauria salicifolia* tree. *RUN: Collapsed crater rim along the Mbeya — Tukuyu road, near Isongole village, 1960 m (6757/B); det. B. Oceanic subcosmopolite.

230. **Campylopus metzlerelloides** (P. Varde et Thér.) Bizot **nov. comb.**
Basionym: *Bryohumbertia metzlerelloides* P. Varde et Thér., Bull. Soc. Bot. Fr. 86: 422, fig. 1 (1939).

Corticolous, lignicolous or terricolous in montane forests. KIL: Umbwe Route 1600–2600 m (6190/K, 6352/AF, 6786/D); Nkweseko 1700–1800 m (6359/V); *WUS: Mazumbai U.F.R. 1750–1880 m (6372/AP, AU); *ULU: Mgeta v. 1600–1640 m (6912/U); Bondwa top 1850–2120 m (6714/C, 6889/T, AG); *UKA: Mnyera ridge 2050 m (6871/AC); Already De Sloover (1976: 431) pointed to its affinity to *Campylopus*. There is no reason, why could it not be classified into Subgen. *Palinocraspis* of *Campylopus*. Det. and annotated by B. EA montane species, detailed distribution given by De Sloover l.c.

231. **Campylopus pilifer** Brid. Syn.: *Campylopus polytrichoides* De Not., *Campylopus introflexus* auct. afr. non (Hedw.) Brid., fide Gradstein and Sipman 1978: 114–121. – Montane forest, terricolous. ULU: Bondwa (c. Harris and students, DSM 2252). The East African specimens kept in EGR were re-examined in the light of the concept of Gradstein and Sipman (l.c.) and all were proved to be *C. pilifer*, not *C. introflexus* s. str., *C. pilifer* is a tropical – warm temperate species according to the above authors, widespread in great part of the Americas, SW Europe, Africa and in SW Asia. On the other hand, *C. introflexus* s. str. is an antipodal temperate species, recently introduced to Europe. Det. and annotation by P.

232. **Campylopus procerus** (C. Müll.) Par. – On the ground of elfin woodland. *UKA: Mamiwa F.R., eastern peak, 2200 m (c. Mabberley 1385/B); det. B. Widespread afromontane species from Cameroon to Tanzania and to Rhodesia, but only at higher altitudes, from 1800 to 4000 m.

233. **Campylopus stramineus** (Mitt.) Jaeg. – On the peaty soil of *Senecio* moorland. KIL: Umbwe Route, 3950 m (6796/D); det. B. Afromontane and subalpine, EAB I, IV.

234. **Atractylocarpus alticaulis** (Broth.) Williams Syn.: *Atractylocarpus naveauanus* (Thér.) P. Varde – In subalpine giant (*Erica arborea*) heath, ru, li. *KIL: Umbwe Route, near the Ist Bivouac, 2850–2900 m (6788/BN, BT, BY); Mweka Route 2580–2800 m (6718/R, AM); det. B. Afroalpine species known only from the Ruwenzori and from the volcanoes of Kivu region.

235. **Rhabdoweisia africana** Dix. et Nav. – On shady, relatively dry, overhanging volcanic rocks. *KIL: Umbwe Route, Ist Bivouac, 2900 m (6788/AA p.p., AV p.p., CA p.p.); det. B. Previously known only from Ruwenzori and Elgon, afroalpine.

236. **Rhabdoweisia lineata** Rich. et Arg. – On more open or on shady, overhanging volcanic rocks in subalpine (*Erica arborea*) giant heath, also together, with the precedent, but more common and widespread. *KIL: Umbwe Route, on the rocks of the Ist and that of the IInd Bivouac, 2850–3330 m (6791/F, GB, NB, 6788/M, 6929/E); det. B and P. Afroalpine (subalpine) species known from Ruwenzori, from the volcanoes of Kivu region and from Mt. Cameroon, between 2400 and 3300 m altitudes.

237. **Holomitrium borbonicum** Hampe ex Besch. var. **hamatum** (C. Müll.) Thér. – Corticolous in elfin woodland. *ULU: Lukwangule Plateau, 2500 m (6080/AL); det. B. Lemurian element, previously known from Madagascar, Réunion and Mauritius, new for East Africa.

238. **Holomitrium cylindraceum** (P. Beauv.) Wijk et Marg. var. **cucullatum** (Besch.) Wijk et Marg. Syn.: *Holomitrium affine* Card. et Thér. var. *cuculla,um* Thér. – Ramicolous in submontane rain forests. EUS: Hunga v. 860 m (6378/L); *NGU: Mhonda Mission, W 800–1000 m (6400/PA); det. B. The var. is EA – Lemurian, the species is Palaeotropic element.

239. **Dicranum johnstonii** Mitt. – On bark and rotting wood in montane forests, giant *Erica arborea* heath and in elfin woodland. KEN: Castle F. St. 2000 m (6603/Y); KIL: Mweka Route 2800 m (6718/AR); *UKA: Mnyera ridge 2100 m (6871/AH, AN); det. B. Widespread afromontane species, EAB I, IV.

240. **Leucoloma aspericuspis** P. Varde – On bark or on shady rocks in montane forests. *NGU: near Mnembule village, 1400 m (6437/AP); ULU: Kinazi NW 1400–1650 m (6289/BE);

Mwere v. 1500—1600 m (6220/N, 6531/G, 6534/O, 6579/E); Lupanga WNW 1500 m (6546/F); Bondwa NE 1650 m (6844/E); Mzinga v. above the falls, 1400—1600 m (6290/AJ); Mgeta v. above Hululu Falls 1600 m (6911/C); det. B. EA montane, EAB I, map in EAB II.

241. **Leucoloma bifidum** (Brid.) Brid. — Corticolous, ramicolous or on bamboo stem in montane forests. *KEN: Castle F. St. 2000 m (6603/X); *WUS: Mazumbai U.F.R. 1500 m (6370/AH); *KIL: Umbwe Route 1700—1900 m (6351/U); Nkweseko 1800—1850 m (6359/W); ULU: Simbini E 1500 m (6418/AR); Midhani 880 m (6881/V); Bondwa NE 1740 m (6578/J); Lupanga top 2140 m (6072/BA); SW 1700—1900 m—(6285/CM); det.B EA — Lemurian, EAB I.

242. **Leucoloma chlorophyllum** Broth. — In submontane and in montane forests, ct, ru. *ULU. Manga E 1150-12 50 m (6225/G); Lupanga — Kinazi 1800—1900 m (6836/AK); det. B. Previously known only from NW Tanzania: Bukoba.

243. **Leucoloma chrysobasilare** (C. Müll.) Jaeg. var. **gracilicaulon** (C. Müll.) Jaeg. Syn.: *L. scabricuspis* Broth. — Corticolous in submontane and in montane forests. *WUS: Mazumbai U.F.R. E 1500 m (6370/AG); ULU: Mwere v. 1470—1580 m (6158/AJ, 6531/F, 6534/P, 6853/A); Tumbako SE 1500—1550 m (6876/A, U); Maunga v. 1400—1600 m (6290/AK); Simbini E 1400—1500 m (6418/AS); Tegetero Mission 1300 m (6427/A); *POR: Lake Ngozi Crater rim 2200—2250 m (6329/VA); *RUN: Mt. Rungwe SW 1800—1900 m (6762/B); det. B. SE African — Lemurian species, from Tanzania to Transvaal and to Madagascar.

244. **Leucoloma cuneifolium** (C. Müll. et Geh.) Wright — Ramicolous in montane rain forest. ULU: Tumbako S 1500 m, SE 1400 m (6877/E, 6876/B); EA — Lemurian species, EAB I.

245. **Leucoloma grimmioides** P. Varde — On shady rocks and on bark in montane forest. *ULU: Lupanga NW 1600—1800 m, SW 1700—1900 m (6548/L, 6285/CB); det. B. EA — Lemurian species, previously known only from Madagascar, new for continental Africa.

246. **Leucoloma holstii** Broth. — Corticolous, often ramicolous in submontane and montane forests and in elfin woodland. KIL: Umbwe Route 1900—2100 m (6352/Aw); Nkweseko 1700—1800 m (6359/Z); WUS: Mazumbai U.F.R. 1750—1880 m (6372/AS); EUS: Amani 900 m (6086/BL, 6380/B); Hunga v. 880 m (6514/H); *NGU: near Kombola village 900—1200 m (6436/L); Dunema 1400—1500 m (6398/X, Z); *ULU: Lupanga SW 1500—1700 m (6284/AL); Lupanga crest 2100 m (6552/G); Lupanga — Kinazi ridge 1800—1900 m (6836/S); Kinole sawmill 900—1050 m (6264/L); Bondwa NNW 1550 m, and top 2120 m (6006/Z, 6889/D, 6052/AG); NE 1740 m, NW 1850—2050 m (6230/U, 6578/AM); Tegetero Mission 1100—1300 m (6426/C); W of Kibungo Mission, 1500—1700 m (6475/AE); Mgeta river v. 1600—1640 m (6912/M); Mt. Kifuru 1875—1980 m (6914/K); Lukwangule Plateau and E escarpment 2350—2500 m (6824/J, 6827/S); *UKA: S of Mandege F. St. 1550—1580 m (6588/E); Ikwemba N ridge, 1900 m (6866/T); Mnyera ridge SSW 1950—2050 m, top 2100 m (6742/K, L, 6740/AK); det. B. EA montane, EAB I, II, IV.

247. **Leucoloma sinuosulum** C. Müll. ex Besch. — Epiphyllous and rupicolous in submontane forests. *NGU: W of Mhonda Mission, 800—1000 m (6400/T); ULU: Mwere v. 1500—1550 m (6893/C); Bondwa E 1600 m (6181/AV); det. B and P. EA — Lemurian, EAB I.

248. **Leucoloma** cf. **terricola** Broth. — Corticolous and terricolous in montane forest. *ULU: Bondwa NE 1750 m (6844/J); det. B. Previously known only from its type locality in the Usambara Mts.

249. **Leucoloma volkensii** Broth. — On rocks and on bark in montane forests and in elfin woodland. NGU: Dunema 1400—1500 m (6398/V, Y); ULU: Lupanga crest E 1750—1950 m (6468/C, F); Lupanga WNW 1900—2050 m ((6550/U); Lupanga-Kinazi ridge 1900 m (6836/R); Mwere v. — Bondwa 1600 m (6180/w, 6534/w, R); Bondwa top 2100 m (6404/AK); NE 1600—2050 m, SE 2000—2100 m (6573/O, 6574/B, 6599/N, 6261/E);

Mgeta v. above Hululu Falls, 1600 m (6912/N); Tumbako SE 1390—1480 m (6876/N); *UKA: Ikwamba top 2000 m (6867/A); det. B. EA montane, EAB I.

250. **Dicranoloma billardieri** (Schwaegr.) Par. — Terricolous and corticolous in altimontane giant *Erica* heath, elfin woodland, montane mossy forest.

— var. **patentifolium** (Ren. et Par.) Thér. — Ulu: Palata NW 1850—1890 m (6852/E, L); Lupanga NW 1800—2000 m (6132/J); det. B.

— var. **scopareolum** (C. Müll.) Thér. *KIL: Umbwe Route 2850—2900 m (6788/A); Mweka Route 2640—2820 m (6718/J, BG); ULU: Lupanga NW 1700—1800 m (6126/E); Lupanga top 2140 m (6072/Z); Bondwa N 1900—2050 m (6051/BH); top 2120 m (6889/AH); Mt. Kifuru 2000 m (6915/C, E); *UKA: Mnyera ridge 2100 m (6740/AL); det. B. Subantarctic species, EAB I, IV.

Leucobryaceae

251. **Leucobryum acutifolium** Broth. — Corticolous, lignicolous and rupicolous in submontane rain forests. *ULU: Nguru ya Ndege 1150—1300 m (6459/S); above Simbini village 1400—1500 m (6418/AX); Tumbako SE 1390—1480 m (6876/G); Hululu Falls 1480 m (6900/C); Bondwa NE 1600—1700 m (6535/J); NNW 2020 m (6403/AL); NW of Kinole village 1000—1500 m (6470/C); Mwere v. 1500 m (6158/AC); det. B. SE African — Lemurian, EAB II, IV.

252. **Leucobryum bistratosum** Broth. — Rupicolous in riverine forest. ULU: Mzuazi v. near Midhani, 845 m (6882/F); det. B. Endemic in the Uluguru Mts.

253. **Leucobryum cucullatum** Broth. — Rupicolous, corticolous or lignicolous in submontane rain forests, or in deciduous woodlands. *ULU: Morningside, 1250 m (6896/A); W of Kibungo Mission, 1500—1700 m (6475/AG); *Z: Mt. Mulilidwa NE of Shiwa Ngandu, 1500 m (6627/w); Kundulila Falls near Kanona, 1480 m (6626/J); det. B. SE African — Lemurian species, EAB I.

— 3 samples seem to be intermediates between the preceding and following taxa: NGU: Duale v. between Mhonda and Kombola, 600—900 m (6435/L); near Kombola village, 900—1200 m (6436/M); ULU: above Morningside, 1350 m (6529/E); det. B.

254. **Leucobryum isleanum** Besch. var. **molle** (C. Müll.) Card. — Submontane and montane forests, ct, ra, ru, te, li. *KIL: Umbwe Route 1700—1900 m (6351/T); Mweka Route 2530 m (6718/DA); *WUS: Mazumbai U.F.R. 1600—1750 m (6371/AF, AG); EUS: Amani 900 m (6380/E); ULU: Bondwa NE 1740 m (6578/F, AO); Tumbako SE 1050—1530 m (6875/B, 6877/T); Tegetero Mission 975 m (6424/G); above Simbini village 1400—1500 m (6418/AY); Lupanga W 1200—1300 m (6064/H); Kikododo above Bunduki, 1600—1750 m (6463/O); above Kibungo Mission, 1500—1700 m (6475/AF, AH); *UKA: Mnyera NNE 1990 m (6870/J); 2 km N of Mandege F. St. 1600 m (c. Mabberley 1428); det. B. EA — Lemurian species, EAB I, IV.

255. **Leucobryum perrotii** Ren. et Card. — Rupicolous in montane forests. *UKA: N of Mandege F. St., 1540 m (6737/R and Mabberley 1363); Mnyera ridge NNE 1900—2100 m (6739/R). Det. B. New to continental Africa, previously known only from Madagascar and from Mauritius, EA — Lemurian species.

256. **Leucophanes cameruniae** C. Müll. — On bark and on rotting wood in submontane rain forest. *EUS: Amani, 900 m (6091/K, 6086/BO); det. P. Tropical African species, known from Guinea to Zaire. New to East Africa.

257. **Leucophanes hildebrandtii** C. Müll. — On *Cyathea* stem or corticolous in submontane and in montane forests. *EUS: Amani, Hunga v., 880 m (6514/K); Botanical Garden (6094/A); ULU: Nguru ya Ndege, summit forest, 1150—1300 m (6459/T); Kinole sawmill 1100 m (6874/D); Mt. Kinazi 1400—1650 m (6289/BN); E of Simbini village 1400—1500 m

(6418/AZ); Kilangala top SE of Bunduki, 1950 m (6464/BO); det. P. EA — Lemurian species, EAB I.

258. **Leucophanes mayottense** Card. — On shady rocks and on *Cyathea* stem in submontane rain forests. *EUS: Ngurue v. E of Chemka village, 500—600 m (6516/T); Amani, Hunga v. 850 m (6094/C); det. P. EA — Lemurian, previously known only from the Comores and the Mascarenes.

259. **Leucophanes renauldii** Card. — On bark in submontane rain forest. *ULU: Lumanga v. N 1150 m (6811/O); det. P. EA — Lemurian, previously known only in Madagascar.

260. **Leucophanes rodriguezii** C. Müll. — On bark, rocks and on *Cyathea* stem in montane rain forests. *UKA: Mt. Kifigo SE 1800 m (6592/M); ULU: Mt. Tumbako SE 1460—1550 m (6876/M, P); det. B. EA — Lemurian species, EAB I.

261. **Leucophanes seychellarum** Besch. — On shady rocks in submontane rain forest. *NGU: Duale v. between Mhonda and Kombola villages, 600—900 m (6435/K); det. B. EA—Lemurian species, previously known only from the Seychelles, new for continental Africa.

Calymperaceae

262. **Calymperopsis disciformis** (C. Müll.) Tix. Syn.: *Thyridium africanum* Mitt. — Epiphyllous in submontane rain forest. *ULU: Mt. Tumbako SE 1050—1390 m (6875/AA); det. ORBÁN. Widespread in the Caribbean region and in tropical Africa.

Pottiaceae

263. **Anoectangium eukilimandscharicum** Dix. — On half shady rocks, seldom on bark in the submontane and montane forest belts. MER: Njeku, 2600 m (6520/J); KIL: Maua village, streamside rocks, 1600 m (6367/E, G); Kikafu gorge near Kyere, 1500 m (6347/F); *ULU: Kisimbi Falls NW of Kinole village, 650 m (6276/L, M, N); road to Bondwa peak 1700 m (6553/H); *RUN: Mt. Kyejo N 1870—1970 m (6772/B, C); det. B. EA montane species, EAB I.

264. **Anoectangium hanningtonii** Mitt. — On half shady rocks of the submontane and montane forest and woodland belt. KIL: Weru-Weru v. near Kissereni, 1260 m (6345/F); ULU: Kigurunyembe, 700 m (6723/D); Mt. Mindu S 1070 (6491/B); Morningside 1150—1350 m (6203/C, 6735/E); S of Mgeta 1340 m (6392/G); *KIP: Kitulo Plateau, 2700 m (6752/M); *RUN: rocky roadcut near Rungwe village, 1450 m (6760/B); *Kundalila Falls near Kanona, 1480 m (6622/K); det. B. EA montane, EAB I.

265. **Weisia controversa** Hedw. cf. var. **gymnostoma** (Dix.) Sainsb. — Terricolous on roadside banks, in dry forests and woodlands, sometimes on bark. *Dar es Salaam, 40 m (c. WINGFIELD); * NGU: Mhonda Mission, 700 m (6433/O); Maskat Mission, 1500 m (6444/S);. ULU: Kitulanghalo F.R. SE 750 m (6856/H); Morogoro, 750 m (6401/AJ); Morningside, 1300 m (6203/H, 6572/A, 6806/A); Chenzema Mission, 1700 m (6812/B, J); *UKA: Mt Ikwamba NW 1700 m (6865/Q); det. B. Cosmopolite, EAB I, IV.

266. **Hymenostylium crassinervium** Broth. et Dix. — In *Phoenix reclinata* stand effected by spray. *Z: Victoria Falls, Knife edge, 870 m (6613/M); EA montane — S African, from Mt. Kenya to Cape, known from the Rhodesian part of the Victoria Falls. Det. B.

267. **Hymenostylium recurvirostre** (Hedw.) Dix. var. **latifolium** (Zett.) Wijk et Marg. Rupicolous; in subalpine ericaceous heath. *KIL: Mweka Base Hut, 2985 m (6719/J); Umbwe Route near IInd Bivouac, 3330 m (6791/D); det. B. Subcosmopolite, the var.: northern temperate. Altimontane in tropical Africa: Ruwenzori and Mt. Meru, 3170—4200 m.

268. **Tortella humilis** (Hedw.) Jenn. Syn.: *T. caespitosa* (Schwaegr.) Limpr. — On roadside

banks. *RUN: near Lake Massoko SE of Tukuyu, 1100 m (6779/G); det. B. Cosmopolite, EAB IV.

269. **Leptodontium flexifolium** (Dicks.) Hpe — Rupicolous in subalpine ericaceous heath. KIL: Umbwe Route, near the IInd Bivouac, 3360 m (6932/D); det. B. Subcosmopolite, altimontane in tropical Africa: Mt. Cameroun, E-Zaire, Mt. Kenya and Mt. Kilimanjaro, 2800—4000 m.
270. **Leptodontium joannis-meyeri** C. Müll. — Terricolous in subalpine heath. KIL: Umbwe Route, near Barrance Hut, 3950 m (6797/BA); det. B. Afroalpine.
271. **Leptodontium luteum** (Tayl.) Mitt. — On the ground of giant (*Erica arborea*) heath. *KIL: Marangu Route 2800 m (6943/A); det. B. Species known from the paramos of the South American Cordilleras in Colombia, Ecuador, Bolivia and Peru, at alt. 2700—4000 m, and also from Mt. Meru in East Africa at 3300 m according to Zander 1972: 265. The species published by Bizot 1973: 23 from Mt. Kenya: Naro Moru track, 2500 m and by Bizot and Pócs 1974: 423 in EAB I, No. 227 from Mt. Kilimanjaro under the name of *Leptodontium volkensii* Broth., using the revision of Zander l.c., proved to be also *Leptodontium luteum* (Tayl.) Mitt., which species has now a typical "afroalpine" distribution pattern in tropical Africa. Annotation by B.
272. **Leptodontium viticulosoides** (P. Beauv.) Wijk. et Marg. var. **viticulosoides** — On bark and on rocks, once even on corrugated iron roof, in the montane forest belt; on giant groundsel (*Senecio johnstonii*) stem in subalpine heath. *KEN: Castle F. St. 2000 m (6605/C); KIL: Marangu Route 2200—3440 m (6365/AC, 6247/R); Umbwe Route 1700—1900 m (6351/R); *NGU: Mt. Mafulumula N 1920 m (6440/O, P); *UKA: Mandege F. St. 1570 m (6859/F, 6860/E); Mt. Kifigo SE 1800 m (6592/N); Mnyera ridge 2020—2060 m (6871/AG); *KIB: Summit above Mwapwa SSE, NE 1800—2000 m (6566/M, 6568/K); *RUN: Mt. Rungwe SW 1800 m (6777/A); *Z: Mukowonshi Mt. 45 km NNE of Mpika, 1920 m (6630/w); det. B. Pantropical, EAB I, IV.
273. **Hyophila acuminata** Broth. et P. Varde — On wet, often on sprayed rocks in lowland and in submontane forests and woodlands. *EUS: Amani 870 m (6095/A); *ULU: Kimboza F.R. 300 m (6728/C); Morogoro, Kigurunyembe 700 m (6723/M); Mt. Mindu SE 570 m, S 950 m (6488/C, 6491/C); Morogoro river v. near Bahati Camp 600 m (6561/F); Kibwe Falls above Morogoro, 1030 m (6712/D); Msanga Falls ESE of Mzinga village, 1150 m (6110/Z); Kisimbi Falls NW of Kinole village, 650 m (6276/O); Nguru ya Ndege E 960 m (6484/F); *UKA falls below Mandege F. St. 1200 m (6744/E); stone walls of Mandege F. St. 1570 m (6869/B); *KIB: above Kikombo, S. 1260 m (6563/M, R, S); *USG: Kilombero Scarp F.R., Kidatu, 600—700 m (6143/M); *Z: 13 km E of Lusaka, 1300 m, on dolomite rocks (6611/B); under Kundalila Falls SE of Kanona, 1430 m (6623/K, L); Victoria Falls, Knife Edge, 870 m (6613/K); det. B. EA montane — Lemurian species.
274. **Weisiopsis plicata** (Mitt.) Broth. — On dry rocks surrounded by secondary grassland. ULU: Mt. Mindu S 1200—1240 m (6843/AJ, AK); det. B. EA — Lemurian, EAB I.
275. **Didymodon rigidulus** Hedw. var. **acutus** Bizot — On bark at the forest line and on subalpine rocks. *MER: Njeku 2600 m (6520/H); Great Meru peak NE 3100 m (6523/B); det. B. The species is a temperate subcosmopolite element, the variety seems to be afromontane, previously known only from Mt. Mbeya at 2400 m alt.
276. **Barbula pertorquata** C. Müll. — In *Brachystegia* woodland, ru, te. *ULU: Nguru ya Ndege, SW ridge, 815 m (6707/U); Mt. Mindu SE 570 m (6488/E); *Z: Along the Great East Road 125 km E of Lusaka, 1300 m (6621/Z); det. B. EA—SA, EAB IV.
277. **Bryoerythrophyllum alpigenum** (Vent.) Chen. — In a shady lava rock cavity. *KIL: near Shira Hut, 3700 m (6926/E); Northern temperate altimontane species: European Alps, Carpathians, Scandinavia, Kashmir, Tchukch Peninsula and Chitral in NE Asia, Arctic North America. In Africa only: Ruwenzori, Bujuku v. at 4000 m.

278. **Bryoerythrophyllum recurvirostre** (Hedw.) Chen. Syn.: *Didymodon rubellus* B. S. G. — On *Senecio cottonii* stem in giant groundsel stands. KIL: Umbwe Route, near Barranco Hut, 3950 m (6795/F); det. B. Cosmopolite, in tropical Africa altimontane, EAB IV.
279. **Bryoerythrophyllum rubrum** (Jur.) Chen Syn.: *Didymodon ruber* Jur. — On *Senecio cottonii* stem and on the ground of giant groundsel stands. *KIL: Umbwe Route, N of Barranco Hut, 3900—4000 m (6933/N, O); det. B. Eurasian altimontane species: Alps, Norway, Caucasus, Tchukch Peninsula, Shensi. New for the African continent.
280. **Streptopogon erythrodontus** (Tayl.) Wils. var. **rutenbergii** (Geh.) Salmon — On bark in relatively dry montane forest, 2300 m (6196/C); det. B. Almost pantropical species, the variety is East African, EAB IV.
281. **Semibarbula orientalis** (Web.) Wijk et Marg. — Terricolous on roadsides. *Dar es Salaam; University Campus, 40 m (c. WINGFIELD 2746); *ULU: Kiroka Pass, 600 m (6020/B). *POR: Igali Pass, 1800 m (6749/F); det. B. Widespread palaeotropical species, EAB I-
282. **Tortula cavallii** Negri — The most common epiphyte of giant *Senecio* stems in the afroalpine paramo vegetation. KIL: Marangu Route near Horombo Hut, 3800 m (6248/T); Umbwe Route near the IInd Bivouac and N of Barranco Hut, 3550—4050 m (6792/Z 6795/F, 6933/P); det. B. Widespread afroalpine species, EAB IV.
283. **Tortula cochlearifolia** P. Varde — In a small lava cavity within the alpine desert zone. KIL: Shira Route near Arrow Glacier Hut. 4500 m (6928/H); det. B. Afroalpine, known only from Kilimanjaro, EAB IV.
284. **Tortula schmidii** (C. Müll.) Broth. Syn.: *Tortula hildebrandtii* (C. Müll.) Broth., *T. erubescens* (C. Müll.) Broth., *Barbula meruensis* C. Müll., etc. fide TOWNSEND 1978: 131. — Epiphyte on giant *Senecios* and terricolous in the subalpine zone. Very widespread on different substrata in the montane zones of East Africa, Arabia and in South India according to TOWNSEND l.c., especially in drier habitats. KIL: Marangu Route 3440—3800 m (6247/S, 6248/G, w); near Shira hut, 3700 m (6925/J); Mawingo estate near Mweka, 1350 m (6350/F); *ULU: Mgeta — Chenzema road, 1340 m (6392/H); *KIP: Kitulo Plateau 2650 m (6750/AO); det. B. An element distributed from South Africa through East Africa — Somalia to Yemen and to the Nilghiris. EAB I, IV, Map in BIZOT, PÓCS and SHARP 1979: 155, does not include the localities published by TOWNSEND l.c.
285. **Tortula pierrotii** Bizot — On dry lava rocks. *RUN: Mt. Kyejo N 1870—1970 m (6772/D); det. B. Previously known only from Mt. Mbeya, not far from the Rungwe Mountains. It will be classified later probably among *Didymodon*, having 2 layers of stereid cells in the leaf midrib and at the tips of certain leaves irregular shaped structures were observed, which might be either propagules or fungi. Sometimes the upper, smaller leaves form very striking rosettes. Annotation by B.

Grimmiaceae

286. **Grimmia afroincurva** Broth. — On open lava rocks in alpine desert. *KIL: Kibo, E foot of the cone above Kibo Hut, 4470 m (6253/A); W slope, in the Great West Breach, above Arrow Glacier Hut, 4820 m (6799/B); det. B. Afroalpine species, previously known from Ruwenzori, Karisimbi and Mt. Meru, betw. 3450 and 4650 m altitudes.
287. **Grimmia trichophylla** Grev. ssp. **lisae** (De Not.) Boul. — Rupicolous in the ericaceous heath belt. *KIL: Umbwe Route, S and W of Barranco Hut, 3900 m (6934/L, 6935/F); Shira Route, near Shira Hut, 3660 m (6927/AD, AL); det. B. Warmer parts of Eurasia and America, Northern Africa. New for tropical Africa.
288. **Grimmia ovalis** (Hedw.) Lindb. Syn.: *G. ovata* W. et M. — On dry rocks above the forest line. MER: N crater rim 3800 m (6525/H); KIL: Mweka Route 3260 m (6720/L); Umbwe

Route near Barranco Hut, 3950 m (6793/N); det. B. Circumboreal species, altimontane in tropical Africa, EAB IV.

289. **Schistidium alpicola** (Hedw.) Limpr. Syn.: *Grimmia alpicola* Sw. — Rupicolous in the subalpine ericaceous heath belt. KIL: Marangu Route, 3440 m (6247/P); Umbwe Route, Barranco Hut, 3850 m (6794/C); *MER: NE 3300 m (6524/A); det. B.

— var. **rivularis** (Brid.) — On submerged streambed rocks. *ULU: Mgeta Falls at the E edge of Lukwangule Plateau, 2350 m (6822/AC, AH p.p.); det. B. Circumboreal temperate species, altimontane in tropical Africa, known from Ruwenzori and from Mt. Kilimanjaro.

290. **Schistidium apocarpum** (Hedw.) B. S. G. ssp. **confertum** (Funck) Loeske Syn.: *Grimmia conferta* Funck. — On bare basaltic rocks in the alpine desert zone. KIL: Great West Breach of the Kibo cone, above the Arrow Glacier Hut, 4860—5050 m (6799/C, D); det. B. Bipolar temperate species, altimontane in tropical Africa. It seems to be the highest ascending moss on the W side of Kibo peak. It is known from Mawenzi peak up to 4800 m and from Mt. Kenya between 4450—5000 m alt.

291. **Rhacomitrium nigro-viride** (C. M.) Par. Syn.: *R. defoliatum* Dix. — On partly submerged streambed rocks at the forest line. *KIL: above Mandara Hut, 2800 m (6942/C); rheomorphic, denudate form, which was described, as *R. defoliatum* Dix. before. Det. B. Afroalpine + Cape.

Funariaceae

292. **Funaria hygrometrica** Hedw. var. **calvescens** (Schwaegr.) Mont. — Syn.: *F. calvescens* Schwaegr. — Terricolous at disturbed sites. MER: Njeku, 2600 m (6520/E; Z: Muchinga Escarpment, Mt. Mulilidwa E, 1500 m (6627/N);

293. **Funaria calcarea** Wahlenb. var. **convexa** (Spruce) Husnot — Syn.: *F. convexa* Spruce — On irrigated, semishaded volcanic rocks surrounded by subalpine ericaceous bush with scattered giant *Senecios*. *KIL: Charongo v. below Mweka Base Hut, 2985 m (6719/A); det. B. Mediterranean Europe and North Africa, Middle East — new for tropical Africa.

294. **Funaria volkensii** Broth. — On bare soil patches in rocky grassland above the forest line. *KIP: Kitulo Plateau, 2700 m (6752/L); det. B. Afroalpine species previously known only from the Ruwenzori, Elgon and Kilimanjaro mountains at much higher altitude.

Splachnaceae

295. **Tayloria orthodonta** (P. Beauv.) Demaret — On bark in montane forest. *NGU: Mt. Mafulumula N above Mnembule village, 1920 m (6440/N); det. P. Widespread afromontane species new for Tanzania.

— **Tayloria solitaria** (Card.) Kop. — The species No. 239 in EAB I: 424 from the Uluguru Mts. under name *T. thoméana* (Broth.) Broth. belongs here. Rectification by B.

Bryaceae

296. **Orthodontium gracile** Schpr. — Corticolous in montane forests. *MER: near Yekukumia, 2100 m (6519/E); det. B. No. 6245/R from Kilimanjaro Mts. published in EAB I: 424 under name of *O. loreifolium* Besch. belongs also here. Rectified by B. Oceanic subcosmopolite.

297. **Orthodontium loreifolium** Besch. — On bark and on rotten wood in submontane and montane forests and in giant *Erica* heath. KIL: Umbwe Route 1900—2900 m (6352/AG, 6787/BG, 6788/AH); Mweka Route 2750—2820 m (6718/CF); det. B. EA montane — Lemurian species.

298. **Mielichoferia cratericola** Broth. — On rocks and soil of subalpine *Philippia* heath. *KIL: Umbwe Route 3330—3850 m (6791/G, 6792/B, 6793/J); Mweka Route above Base Hut, 3250 m (6720/P); Marangu Route, E of Horombo Hut, 3600 m (6940/C); with short, *M. mildbraedii* like seta, but the spores are slightly papillose. *M. mildbraedii* Broth. has verrucose spores. Det. and annotation by BIZOT. Afroalpine species previously known only from Mt. Kenya and from Ninagongo volcano, at 3500—3950 m alt.

299. **Mielichoferia elgonensis** P. Varde — On lava rocks in the giant *Erica* heath. *KIL: Umbwe Route 2850—2900 m (6788/L); det. B. Afroalpine, previously known only from Mt. Elgon at 3600 m alt.

300. **Mielichoferia mildbraedii** Broth. — On dry rocks surrounded by *Helichrysum* cushion vegetation. KIL: Umbwe Route, near Barranco Hut, 3800—3950 m (6793/H); det. B. Widespread afroalpine species.

301. **Pohlia afrocruda** (C. Müll.) Broth. — On the floor of a small lava cave in the *Helichrysum* belt. KIL: S of Shira Hut, 3600 m (6927/L, w); zet. B. Afroalpine species known from Ruwenzori, Elgon, Mt. Kenya and Kilimanjaro at 3750—4250 alt.

302. **Pohlia chrysoblasta** (Thér. et Nav.) Demaret — On bark of a sole *Agauria salicifolia* (*Ericaceae*) tree. *RUN: At the edge of a small collapsed parasite crater S of Isongole village, 1960 m (6757/C); det. B. Afroalpine species previously known only from Ruwenzori at 3500 m and from Muhawura at 4000 m altitude.

303. **Pohlia elongata** Hedw. — On rocks in the ericaceous belt. KIL: Umbwe Route 2900—3330 m (6788/K, AB, 6791/GC, 6932/T); det. B. Subcosmopolite.

304. **Pohlia longicollis** (Sw.) Lindb. — On ground of montane forest. *KEN: Kamweti track, 2400—2700 m (6601/Z); det. B. Circumboreal, not recorded yet from Africa.

305. **Pohlia philonotula** (C. Müll.) Broth. — On roadcut surface. ULU: Chenzema Mission 1700 m (6812/K); det. B. EA montane — SA, EAB I, IV.

306. **Brachymenium acuminatum** Harv. in Hook. Syn.: *Brachymenium borgenianum* Hampe — Terricolous in relatively dry forests, on roadsides and even on *Velloziaceae* stem. KIL: Old Moshi — Kidia 1700 m (6210/E); Near Kigoma at Lake Tanganyika (c. FÜLEKY); ULU: Mt. Mindu E 600 m (6840/A); Z: Muchinga Escarpment, Mt. Mulilidwa NE of Shiwa Ngandu, E 1500 m (6627/L); det. B and P. Pantropical, widespread in tropical Africa.

307. **Brachymenium angolense** (Welw. et Dub.) Jaeg. Syn.: *B. campylotrichum* (C. Müll.) Broth., *holstii* Broth. — It forms dense cushions on the branches of *Brachystegia* trees in miombo woodland. ULU: Mt. Mindu E 850—1150 m (6841/B); *Z: 30 km NE of Choma, 1000 m (6612/B); det. B. Widespread in the woodland belt of S and E tropical Africa, EAB I, II, IV.

308. **Brachymenium capitulatum** (Mitt.) Kindb. — On bark, in montane woodland. KIL: Marangu, near waterfall, 1220 m (c. ARCHBOLD 1508); Lyamungu Coffee Research Station 1260 m (6195/K); det. B and P, from tropical Africa to E Himalaya, EAB I, II, IV.

309. **Brachymenium leptophyllum** (C. Müll.) Jaeg. — On *Acacia* bark. *KIB: highest summit above Mpwapwa, 1960 m (6568/H); det. P. Widespread in tropical Africa.

310. **Brachymenium procerrimum** Broth. Probably conspecific with *Brachymenium elgonense* Dix. The comparison of their types is necessary to prove their identity. — On bamboo stem in *Arundinaria alpina* thicket. *KEN: above Kamweti F. St. 2400—2700 m (6601/w, BA); det. B and T. Afroalpine, known from Ruwenzori, Mt. Elgon and from Mt. Meru.

— **Brachymenium flexifolium** Bruch. et Schimp. Det. and published by BIZOT (1973: 26) from Ethiopia, as *B. abyssinicum*. Revised by P. NE African montane species, from Ethiopia to Ruwenzori Mts.

311. **Brachymenium longicolle** Thér. — Ramicolous in montane forest. *ULU: Bondwa NE 1985 m (6845/L); det. P. Previously known from Cameroun, Malawi, Mauritius and from Sikkim Himalaya.
312. **Brachymenium pulchrum** Hook. Syn.: *B. argenteum* Thér. — It forms cushions on branches of *Brachystegia* spp. in mist effected miombo woodland, similarly to *B. angolense*. *T: Mt. Ipiri S of Babati, 1800 m (6214/G); det. P. SE African — Lemurian species.
313. **Brachymenium speirocladum** C. Müll. On bark of planted *Eucalyptus* and *Cupressus*. *ULU: Chenzema Mission, 1700 m (6812/w); det. P. Tropical African, from Cameroon to Comores.
314. **Anomobryum filiforme** (Dicks.) Solms. — On rocks among *Helichrysum* cushions. KIL: Shira Plateau, 3660 m (6927/AK); det. P. Circumboreal element, widespread in the high mountains of tropical Africa, EAB I, II, IV.
315. **Bryum alpinum** Huds. ex With. incl. var. **perrevolutum** P. Varde — On wet rocks. CAM: Mt. Cameroon summit, 4000 m (c. BALÁZS 81/r); ULU: Mgeta Falls at the E edge of Lukwangule Plateau, 2350 m (6822/Z); Hululu Falls SSE of Bunduki, 1560 m (6910/C); det. B and P. Cosmopolite, montane in tropical Africa.
316. **Bryum afrocalophyllum** P. Varde — On bark in montane forest or on irrigated lava rocks in the subalpine *Philippia* belt. KEN: Castle F. St., 2000 m (6605/A); KIL: Umbwe Route, from the IInd Bivouac to Barranco Hut, 3360—3850 m (6932/BB, 6794/A); det. B and P. Afroalpine, known only from Kenya and Kilimanjaro Mts.
317. **Bryum argenteum** Hedw. — On very different substrates, as flowerpot, alpine semi-desert rocks and old leopard dung. T: Mwanza town (6199/A); KIL: around Barranco Hut, 3950—4000 m (6797/C, 6798/B, 6933/G, 6934/G); MER: Njeku 1600 m (6520/F); Z: Kafue Gorge below the dam, 1050 m (c. KORNAŚ B 12); det. B and P. Widespread cosmopolite.
318. **Bryum billardieri** Schwaegr. — Ct, ru, te in submontane and in montane woodland, forests. *Mt. Ipiri S of Babati, 1800 m (6215/D); *ULU: Bondwa NW 1650 m (6006/AE); *SHL: Mufindi Fishing Camp 1720 m (6323/P); the specimens published in EAB I under name *Bryum* cf. *homalobolax* C. Müll. ex Ren. from the Uluguru Mts. (6152/X); under name *Bryum* cf. *keniae* (C. Müll.) Broth. from the East Usambara Mts. (coll. No. 6086/AJ), also belong here. Widespread pantropical species. Det. and rectifications by P.
319. **Bryum coronatum** Schwaegr. — Ru, te at roadsides. *NGU: Mhonda Mission, 600—700 m (6433/E); ULU: Morogoro v. at Bahati Camp, 600 m (6561/E); *Z: Muchinga Escarpment, Mt. Mulilidwa, E 1500 m (6627/O); det. B. Pantropical.
320. **Bryum ellipsifolium** C. Müll. — Terricolous among *Helichrysum* cushions; along water-course in the alpine desert zone. KIL: Near Shira Hut 3700 m (6925/A); Shira Route towards Arrow Glacier Hut, 4500 m (6928/G); Known only from the alpine belt of Mt. Kilimanjaro and Mt. Kenya at 3000—4600 m, and from Chile, Fuegia. Det. P.
321. **Bryum huillense** Welw. et Dub. — On ground or on rocks, seldom on bark in submontane and in montane forests, usually below 1500 m altitude. KIL: Marangu, near Kinukamari Falls, 1220—1500 m (6237/O, ARCHBOLD 1504); WUS: Mazumbai U.F.R. 1750—1880 m (6372/BM); EUS: Amani, on concrete pillars of a dam, 950 m (6095/E); KAN: S 1000—1100 m (6137/AJ); *ULU: Mkungwe F.R. W 700—800 m (6217/H); Nguru ya Ndege S 900—1050 m (6457/L, 6448/AC); Palata ridge 1600—1700 m (6850/E); Mt. Mindu SW 1170—1275 m (6492/V); *UKA: Mamiwa ridge E, 2200 m (c. MABBERLEY 1388); det. P. The specimens No. 6380/G from EUS, No. 6011/Q and 6328/E from ULU, and 6329/AW

from POR, published in EAB I: 426, under species No. 264 and 266, also belong here *Bryum huillense* is a very variable, widespread pantropical species, and, having *Bryum* type costa, belongs to the genus *Bryum* s. str. (Subgenus *Bryum*), Sectio *Rosulata*, and not to *Rhodobryum*, if we take in account the characters enumerated by IWATSUKI and KOPONEN (1972). Further misidentified *B. huillense* specimens: BRASS, VERNAY Nyassaland Expedition (No. 16589, NY) from Malawi: Luchenya Plateau, 1820 m (identified by E. B. BARTRAM as *B. truncorum* Brid.) and LARSEN, SMITINAND and WARNCKE (No. 1032, AAU, EGR) from Thailand: Phitsanulok, Puh Mieng Mt., 1300 m identified as *Rhodobryum roseum* (Hedw.) Limpr. Revision and annotation by P.

322. **Bryum keniae** C. Müll. Syn.: *Rhodobryum keniae* (C. Müll.) Broth. — On the soil, rocks and on barks in submontane and montane forests, usually above 1500 m altitude up to 3000 m. *ABE: Gikururu river v. 1.5 km W of Kiandogoro Gate, at *Senecio battiscombei* base, 2950 m (c. MABBERLEY 358); KEN: abowe Kamweti F. St., 2400—2700 m (6601/AZ); KIL: Umbwe Route 1900—2100 m (6352/AD); WUS: Mazumbai U.F.R. 1500—1640 m (6370/AP, 6374/CA); KAN: S 1370 m (6140/X); ULU: Bondwa NE 1740 m (6578/AL); Lupanga W 1350—1500 m (6546/J); *UKA: Mnyera ridge SSW 2050—2100 m (6741/F, 6871'AD); RUN: Mt. Rungwe NE 2400 m, E 2400—2600 m (6327/H, 6503/U, 6504/Z); *MUL: Lichenya Plateau 1800—2000 m (c. RYVARDEN 11761); Specimens No. 6239/J and 6228/C published in EAB I under the name of *Rhodobryum spathulosifolium* (C. Müll.) Par. from Kilimanjaro and Uluguru Mts. belong also here. *Bryum keniae*, similarly to the preceding species, is a typical, althought very tall, representative of the genus *Bryum*, subgen. *Bryum*, sect. *Rosulata* and has only convergency in size and shape with the *Rhodobrya*. In fact, it is very closely related to *Bryum huillense*, the differences between the two are only quantitative. *B. keniae* is much taller in all parts, including the spore size. It is possible, that *B. keniae* will be proved to be a polyploid of *B. huillense*, isolated in the montane forest belt of tropical Africa. Afromontane species, EAB I, IV. Identification, revision and annotation by P.

323. **Bryum leptoneurum** P. Varde — On the ground of altimontane ericaceous heath. KIL: Mweka Route 2750—2830 m (6718/F-2); *ULU: Bondwa top 2120 m (6700/B, 6846/A); Magari peak 2345 m (6300/AG); det. H. Ochi. EA montane species, closely related to the West and Central African montane *Bryum preussii* Broth. They both belong to subgen. *Bryum*, Sect. *Rosulata*, and only differ in leaf size (*B. preussii* has bigger leaves) and in leaf shape (*B. leptoneurum* has acute apex with excurrent costa, *B. preussii* has obtuse, apiculate apex with costa ending in or below the apex). Both have *Bryum* type costa structure, but *B. leptoneurum* has 2, *B. preussii* usually has 3 layers of large cells above the stereids. Annotation by P.

324. **Bryum micro-erythrocarpum** C. Müll. et Kindb. Syn.: *B. zuluense* Broth. et Bryhn — *W-Transvaal: Barberspan Bird R. St., on irrigated ground (c. FARKAS No. 1, May 1965); det. P. Subcosmopolite species known in Africa from Cape, Natal and Zululand.

325. **Bryum pallens** Sw. Syn.: *B. pterocaulon* P. Varde — On rocks, bark and on rotten wood. *KEN: below Castle Forest St. 1950 m (6603/H); *KIP: Kitulo Plateau 2650 m (6750/AT); det. B. Circumboreal species very rare in tropical African mountains.

326. **Bryum pseudotriquetrum** (Hedw.) Gaertn. et al. Syn.: *B. ventricosum* Dicks. — On irrigated rocks. ULU: Mgeta Falls at the E edge of Lukwangule Plateau, 2350 m (6822/AL); *UKA: near a waterfall below Mandege F. St., 1200 m (6744/F); det. B. Widespread cosmopolite species.

327. **Bryum staudtii** Broth. — Corticolous in montane forest. *MAL: Zomba Plateau, 1450 m (c. BRASS, VERNAY Nyasaland Expedition No. 16209), identified and published by E. B. BARTRAM (1953), as *Bryum truncorum* Brid. *B. staudtii*, previously known only from Cameroon, is also a member of section *Rosulata*, and not *Rhodobryum*. It is very closely

related (and maybe will proved to be conspecific) to *Bryum huillense* Welw. et Dub. Revision and annotation by P.

328. **Bryum viguieri** Thér. — Rupicolous in *Brachystegia* woodland. *MAL: Nchisi Mt., 1400 m (c. Brass, Vernay Nyasaland Expedition No. 16946), identified and published by E. B. Bartram (1953) as *Bryum truncorum* Brid. Previously known only from Madagascar and from Angola. Rev. by P. (NY, EGR)

329. **Rhodobryum commersonii** (Schwaegr.) Par. — Corticolous in montane forest. *ULU: Bondwa NE 1950 m (6579/G); det. P. *Rhodobryum commersonii* has true *Rhodobryum* or *Mnium* type midrib section and agrees in other characters too with the genus *Rhodobryum* as defined by Iwatsuki and Koponen (1972: 3), and seems to be very closely related to *Rhodobryum madurense* Dix. et P. Varde. *R. commersonii* is a palaeotropic species known from East Africa to India.

330. **Rhodobryum perspinidens** (Broth.) Pócs, **comb. nov.**

Basionym.: *Bryum perspinidens* Broth., Bot. Jahrb. 24: 246 (1897). The investigation of costa anatomy of this interesting species proved the right of Ochi, who has placed it in the subgenus *Rhodobryum* Schimp. (Ochi 1972: 118). Although our collections are sterile, similarly to the type, the vegetative characters show close relationship to *Bryum aubertii* (Schwaegr.) Brid. — On soil of elfin woodland. ULU: Lupanga — Kinazi ridge, 1800—1900 m (6836/AL); det. B. EA montane, EAB I.

— **Rhodobryum spathulatum** (Hornsch.) Pócs, **comb. nov.**

Basionym: *Mnium spathulatum* Hornsch. Linnaea 15: 135 (1841)
non *Mnium spathulatum* Mitt., Trans. Linn. Soc. 1891: 166

Syn. nov.: *Bryum ontariense* Kindb., Ottawa Naturalist 2: 155 (1889)
Rhodobryum ontariense (Kindb.) Kindb., Spec. Europ. North-amer. Bryin. II: 346 (1897)
Rhodobryum roseum auct. africani, non (Hedw.) Gaertn.
Bryum leucothrix C. Müll., Hedwigia 38: 69 (1899)
Bryum integrifolium Rehm. in Geh., Rev. Bryol. 5: 70 (1878) nom. nud.

Since Ochi (1972: 11) has published *Mnium spathulatum*, as a synonym of *Bryum* (*Rhodobryum*) *roseum* and in the same year Iwatsuki and Koponen have cleared the difference between *Bryum* and *Rhodobryum* and have given good distinguishing characters between *Rhodobryum roseum* and *Rh. ontariense*, it became problematical, where does belong the South African plant known under the name of *Bryum* (*Rhodobryum*) *roseum*. By the kindness of T. Koponen, I was able to examine the isotype of *Bryum integrifolium* from H. Comparing it with other African and European plants and with the descriptions of the above South African taxa, became clear, that the South African "*Rhodobryum roseum*" belong to *Rh. ontariense*. This way the synonym discovered by Ochi is to be used for the plant

known from the northern temperate and subtropical regions under the name of *Rhodobryum ontariense*, which has — similarly to many South African plants — a bipolar distribution pattern. It is still necessary to examine the Uganda and Malawi specimens enumerated in OCHI's revision, from this point of view. Finally from the 10 species listed in OCHI's Revision of African Bryoideae (1972: 107) under the subgenus *Rhodobryum* Schimp. only the 4 following species are true *Rhodobrya*:

Rhodobryum spathulatum (Hornsch.) Pócs
Rhodobryum giganteum (Schwaegr.) Arnott
Rhodobryum perspinidens (Broth.) Pócs
Rhodobryum commersonii (Schwaegr.) Brid.

The position of *Bryum aubertii* (Schwaegr.) Brid. and that of *B. umbraculum* Burch. ex Hook. is to be examined. *Bryum huillense* Welw. et Dub., *B. staudtii* Broth., *B. keniae* C. Müll. and *B. preussii* Broth. remain in the genus *Bryum* s. str., within subgenus *Bryum* and most probably in the section *Rosulata*. Annotation by P.

REFERENCES

The list includes only works not enumerated in East African Bryophytes I, II or IV.

Hepaticae

BISCHLER, H. (1976): *Exormotheca pustulosa* Mitten. Distribution, écologie, caryotype, spores, parois sporales, germination. Rev. Bryol. Lichénol. **42,** 769—783.
BISCHLER, H. (1977): *Plagiochasma* Lehm. et Lindenb. I. Le genre et ses subdivisions. Rev. Bryol. Lichénol. **43,** 67—109.
BISCHLER, H. (1978): *Plagiochasma* Lehm. et Lindenb. II. Les taxa européens et africains. Rev. Bryol. Lichénol. **44,** 223—300.
BAUDOIN, R.—BISCHLER, H. (1978): Analyse statistique du genre *Plagiochasma* Lehm. et Lindenb. Étude du sous-genre *Plagiochasma* en Afrique. Rev. Bryol. Lichénol. **44,** 301—311.
ENGEL, J. J. (1975): *Hepaticae* and *Anthocerotae* collected by DR. HAROLD E. MOORE, Jr. in New Caledonia, Seychelles, Mauritius and Réunion in 1972. The Bryologist **78,** 361—362.
GROLLE, R. (1974): Eine neue *Taxilejeunea* aus Madagaskar und Réunion. J. Bryol. **8,** 93—96.
GROLLE, R. (1975): *Haplolejeunea* aus Madagaskar — eine weitere neue Gattung der Tuyamaelloideae. Journ. Hattori Bot. Lab. **39,** 203—210.
GROLLE, R. (1976): *Drepanolejeunea* subgen. *Kolpolejeunea* — eine neue Untergattung aus der Paläotropis. Journ. Hattori Bot. Lab. **40,** 191—216.
GROLLE, R. (1977): Miscellanea hepaticologica 161—170. J. Bryol. **9,** 529—538.
GROLLE, R. (1978): Die Lebermoose der Seychellen. Wiss. Ztschr. Friedrich Schiller Univ. Jena, Math.-Nat. **27,** 7—17.
GROLLE, R.—ONRAEDT, M. (1974): Lebermoose aus Madagaskar und den Maskarenen (1). Lindbergia 2, 230—233.
JONES, E. W. (1974): African Hepatics XXV. *Rectolejeunea*. J. Bryol. **8,** 71—75.
JONES, E. W. (1974): African Hepatics XXVI. The *Lejeunea eckloniana* complex. J. Bryol. **8,** 77—91.
JONES, E. W. (1975): African Hepatics. XXVII. *Bazzania*. J. Bryol. **9,** 299—316.
JONES, E. W. (1976): African Hepatics XXVIII. *Schistochila* Dum. J. Bryol. **9,** 33—41.
JONES, E. W. (1976): African Hepatics XXIX. Some new or little-known species and extensions of range. J. Bryol. **9,** 43—54.

JONES, E. W. (1977): African Hepatics. XXX. The genus *Radula* Dumortier. J. Bryol. **9,** 461—504.
JOVET-AST, S. (1949): Contribution à l'étude des oléocorps des Hépatiques. Rev. Bryol. Lichénol. **18,** 43—44.
JOVET-AST, S. (1960): Sur quelques Hépatiques de Côte d'Ivoire. Rev. Bryol. Lichénol. **29,** 44—48.
JOVET-AST, S. (1976): Complémets à la connaissance des *Colura:* Espèce et localités nouvel es. Rev. Bryol. Lichénol. **42,** 909—922.
KUWAHARA, Y. (1973): Further notes on the Production of Vegetative Thallus Structures by Female Involucres of *Metzgeria*, and a New Species of Metzgeria. The Bryologist **76,** 566—571.
ONRAEDT, M. (1977): Bryophytes des îles mascareno-malgaches et Seychelles III. Hepaticae: *Bazzania.* Bull. Jard. Bot. Nat. Belg. **47,** 139—144.
PÓCS, T. (1974): Epiphyllous liverworts from Zambia. Bull. Acad. Pol. Sci. Ser. Biol. **22,** 851—853.
PÓCS, T. (1975): New or little known epiphyllous liverworts I. *Cololejeunea* from Tropical Africa. Acta Bot. Acad. Sc. Hung. **21,** 353—375.
PÓCS, T. (1976): Botanical collections made in East Africa during 1969—1973. Boissiera **24,** 605.
PÓCS, T. (1976): Correlations between the tropical African and Asian Bryofloras, I. Journ. Hattori Bot. Lab. **41,** 95—106.
PÓCS, T. (1978): Epiphyllous communities and their distribution in East Africa. Congrès Internat. de Bryologie, Bordeaux 21—23 Novembre 1977. Comptes Rendus (Bryophytorum Bibliotheca **13**), 681—714.
TIXIER, P. (1975): Contribution à l'étude de l'hépaticologie africaine I. Récoltes en bordure du Golfe de Guinée (Cameroun et Gabon). Ann. Fac. Sc. Yaoundé **20,** 3—10.
TIXIER, P. (1977): Espèces nouvelles malgaches du genre *Diplasiolejeunea* (Spruce) Schiffn. (*Heparicae*). Lindbergia **4,** 117—125.
VANDEN BERGHEN, C. (1976): *Frullaniaceae* (*Hepaticae*) africaine. Bull. Jard. Bot. Nat. Belg. **46,** 1—220.
VANDEN BERGHEN, C. (1976): *Frullaniaceae* (*Hepaticae*). Distrib. Plantarum Africanarum **11,** 335—372.
VANDEN BERGHEN, C. (1976): Deux Lejeuneacées Holostipées nouvelles pour la flore africaine. Rev. Bryol. Lichénol. **42,** 923—929.
VANDEN-BERGHEN, C. (1977): Hépatiques épiphylles récoltées par J. L. De Sloover au Kivu (Zaïre), au Rwanda et au Burundi. Bull. Jard. Bot. Nat. Belg. **47,** 199—246.
VANDEN BERGHEN, C. (1978): Notes sur quelques Lejeunéacées Holostipées africaines. Rev. Bryol. Lichénol. **44,** 123—132.
VANDEN BERGHEN, C. (1978): Hépatiques épiphylles récoltées en Rhodésie. Rev. Bryol. Lichénol. **44,** 443—452.
YAMADA, K. (1975): Notes on *Radula* from Tanzania, East Africa. Journ. Jap. Bot. **50,** 19—22.

Musci

BIZOT, M. (1972): Rectifications. Rev. Bryol. et Lichénol. **38,** 593—594.
BIZOT, M. (1974): Enumeratio muscorum novarum. Rev. Bryol. et Lichénol. **40,** 101—138.
BIZOT, M. (1976): Enumeratio muscorum novarum. II. Rev. Bryol. et Lichénol. **42,** 843—855.
BIZOT, M.—M. N. DURY (1978): Quelques mousses de Tanzanie. Rev. Bryol. et Lichénol. **44,** 71—75.
BIZOT, M.—G. KILBERTUS (1979): Les *Campylopus* africains, subg. *Lucidus* Biz. et Kilb. Rev. Bryol. et Lichénol. **45,** 61—95.
BIZOT, M.—T. PÓCS (1974): East African Bryophytes I. Acta Acad. Paed. Agriensis, Eger, n. ser. **12,** 383—449.
BIZOT, M.—M. N. DURY—T. PÓCS (1976): East African Bryophytes, II. Collections made by L. RYVARDEN in Malawi, SE Africa. Acta Bot. Acad. Sc. Hung. **22,** 1—8.
BIZOT, M.—I. FRIIS—J. LEWINSKY—T. PÓCS (1978): East African Bryophytes IV. Danish collections. Lindbergia **4,** 259—284.
BIZOT, M.—T. PÓCS—A. J. SHARP (1979): Results of a bryogeographical expedition to East Africa in 1968, II. Journ. Hattori Bot. Lab. **45,** 145—165.
BRUGGEMANN-NANNENGA, M. A. (1978): A new species of *Fissidens* from Tanzania. Proc. Kon. Ned. Akad. Wet., Amsterdam, ser. **C 81,** 249—251.
CROSBY, M. R. (1977): Index Muscorum Supplementum: 1974—1975. Taxon **26,** 285—307.

CUFODONTIS, G. (1951): Vorläufige Aufzählung der Laubmoose Äthiopiens. Österr. Botan. Zeitschr. **98,** 217—244.
DEMARET, F. (1952): Complément à l'étude des espèces africaines du genre *Cyclodictyon* Mitt. Bull. Jard. Bot. Bruxelles **22,** 155—158.
DEMARET, F. (1955): Étude préliminaire des *Hookeriaceae* africaines intertropicales. Bull. Jard. Bot. Brux. **25,** 375—390.
DEMARET, F.—R. POTIER DE LA VARDE (1951): Les espèces africaines du genre *Cyclodictyon* Mitt. Bull. Jard. Bot. Bruxelles **21,** 11—59.
DEMARET, F.—R. POTIER DE LA VARDE (1952): Les espèces africaines du genre *Callicostella* (C. Müll.) Jaeg. Bull. Jard. Bot. Brux. **22,** 323—396.
DEMARET, F.—R. POTIER DE LA VARDE (1977): Contribution à l'étude des mousses de Ruwenzori. Bull. Jard. Bot. Nat. Belg. **47,** 409—434.
DE SLOOVER, J. L. (1973): Note de bryologie africaine I. — *Brachydontium, Atractylocarpus, Amphidium, Rhabdoweisia, Trachypodopsis.* Bull. Jard. Bot. Nat. Belg. **43,** 333—348.
DE SLOOVER, J. L. (1975): Note de bryologie africaine II. — *Oreoweisia, Eriopus, Cyclodictyon Hookeriopsis, Lepidopilidium, Lepidopilum.* Bull. Jard. Bot. Nat. Belg. *45:* 103—124.
DE SLOOVER, J. L. (1975): Note de la bryologie africaine III. — *Physcomitrella magdalenae* sp. nov. Bull. Jard. Bot. Nat. Belg. *45:* 131—135.
De SLOOVER, J. L. (1975): Note de bryologie africaine IV. *Breutelia.* Bull. Jard. Bot. Nat. Belg. *45:* 237—241.
DE SLOOVER, J. L. (1975): Note de la bryologie africaine V. — *Anacolia, Leiomela, Cyatophorella.* Bull. Jard. Bot. Nat. Belg. **45,** 313—321.
DE SLOOVER, J. L. (1976): Note de bryologie africaine VI. — *Hylocomiopsis.* Bull. Jard. Bot. Nat. Belg. **46,** 379—385.
DE SLOOVER, J. L. (1976): Note de bryologie africaine VII. *Pseudephemerum, Bryohumbertia, Eucladium, Streptopogon, Ptychomitrium, Rhachithecium, Antitrichia, Pterogonium, Lindigia, Distichophyllum.* Bull. Jard. Bot. Nat. Belg. **46,** 427—447.
DE SLOOVER, J. L. (1977): Note de bryologie africaine VIII. — *Neckera, Neckeropsis.* Bull. Jard. Bot. Nat. Belg. **47,** 31—48.
DE SLOOVER, J. L. (1977): Note de bryologie africaine IX. — *Andreaea, Racomitrium, Gymnostomiella, Thuidium.* Bull. Jard. Bot. Nat. Belg. **47,** 155—181.
DE SLOOVER, J. L. (1978): *Bartramia elliottii* Broth. synonyme nouveau de *Anacolia laevisphaera* (Tayl.) Flowers. Bull. Jard. Bot. Nat. Belg. **48,** 240.
EEN, G. (1976): Mosses from the Mascarenes. Lindbergia **3,** 213—217.
EEN, G. (1977): Mosses from the Mascarenes — 2. Lindbergia **4,** 219—223.
GRADSTEIN, S. R.—H. J. M. SIPMAN (1978): Taxonomy and World Distribution of *Campylopus introflexus* and *C. pilifer* (= *C. polytrichoides*): a New Synthesis. The Bryologist **81,** 114—121.
IWATSUKI, Z.—T. KOPONEN (1972): On the taxonomy and distribution of *Rhodobryum roseum* and its related species (*Bryophyta*). Acta Bot. Fennica **96,** 1—22.
KOPONEN, A. (1975): *Tayloria pocsii,* spec. nova (*Musci, Splachnaceae*) from Mt. Kilimanjaro, Tanzania. Ann. Bot. Fennici **12,** 22—24.
LEWINSKY, J. (1978): The Genus *Orthotrichum* Hedw. (Musci) in Africa South of the Tropic of Cancer. Bot. Tidskrift **72,** 61—85.
MAGILL, R. E.—E. A. SCHELPE (1979): The Bryophytes of South Africa. An annotated checklist. Memoirs of the Botanical Survey of South Africa **43,** 1—39.
OCHI, H. (1969): Notes on moss flora VI. Hikobia **5,** 153—170.
OCHI, H. (1972): Some problems of distributional patterns and speciation in the subfamily Bryoideae in the regions including Eurasia, Africa and Oceania. Journ. Hattori Bot. Lab: **35,** 50—67.
OCHI, H. (1972): A Revision of African *Bryoideae, Musci* (First Part). Journ. Facult. Educ. Tottori Univ. **23,** 1—126.
OCHI, H. (1973): A Revision of African *Bryoideae, Musci* (Second Part). Journ. Facult. Educ. Tottori Univ. **24,** 23—50.
OCHI, H. (1974): Some Bryaceous "Old World" Mosses, also Distributed in the New World. Journ. Facult. Educ. Tottori University **25,** 35—41.
ONRAEDT, M. (1976): Bryophytes des îles mascareno-malgaches et Seychelles I et II. Bull. Jard. Bot. Nat. Belg. **46,** 351—378.
ORBÁN, S. (1977): Studies on African *Calymperaceae* I. Acta Bot. Acad. Sc. Hung. **23,** 167—177.
ORBÁN, S. (1978): Studies on African *Calymperaceae* II. Acta Bot. Acad. Sc. Hung. **24,** 113—120.
ORBÁN, S.—T. PÓCS (1976): *Rhodobryum ontariense* (Kindb.) Kindb. in Central Europe. Acta Bot. Acad. Sc. Hung. **22,** 437—448.

PETIT, E. (1978): Clefs pour la détermination des familles et des genres des mousses pleurocarpes (Musci) d'Afrique. Bull. Jard. Bot. Nat. Belg. **48,** 135–181.
PÓCS, T. (1977): Type catalogue of the Bryophyte Herbarium of Ho Si Minh Teachers' College, Eger, Hungary. Fol. Hist. nat. Mus. Matr. **4,** 15–36.
RICHARDS, P. W.—S. R. EDWARDS (1972): Notes on African mosses V. J. Bryol. **7,** 47–60.
SCHULZE-MOTEL, W. (1975): Katalog der Laubmoose von West-Afrika. Willdenowia **7,** 473–535.
STAFLEU, F. A. (red., 1972): International Code of Botanical Nomenclature, adopted by the Eleventh International Botanical Congress, Seattle, August 1969. Utrecht, 426 pp.
TAYLOR, J.—R. POTIER DE LA VARDE (1954): A contribution to the moss flora of tropical Africa. Kew Bulletin **4,** 505–516.
TOWNSEND, C. C. (1978): Notes on mosses from Ceylon and India, 1–5. J. Bryol. **10,** 125–137.
VÁŇA, J.—T. PÓCS—J. L. DE SLOOVER (1979): Hépatiques d'Afrique tropicale. Lejeunia. n. ser. *98*: 1—23.

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CLASIFICACIÓN FITOCENOLÓGICA DE LA VEGETACIÓN DE CUBA

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Authors studied the physiognomic structure and floristic phytosociological composition of the most important and frequent types and associations of the vegetation in Cuba during the last 10 years. Based on these studies the most common and distributed basic and higher units of vegetation and their phytosociological hierarchy were established. As a result of this work the first systematic review of higher phytosociological units (classes, orders, alliances) is contributed accompanied by their short descriptions and characteristical floristic combinations and enumerating the names of the studied associations of each higher unit. The review contains 27 classes of associations, 14 of them are new to science: *Salvinio-Eichhornietea*, *Cabombo-Nymphaeetea*, *Parvirhynchosporeto-Eriocauletea*, *Sesuvio-Rhachicallidetea*, *Chrysobalano-Annonetea glabrae*, *Sabalo-Roystonietea*, *Curatello-Byrsonimetea*, *Coccolobetea uviferae*, *Phyllantho-Neobracetea valenzuelanae*, *Byrsonimo-Pinetea*, *Caseario-Pinetea*, *Ocoteo-Magnolietea*, *Rondeletio-Gesnerietea*, *Clusio-Ilicetea*; furthermore 53 phytosociological orders, 80 alliances and 186 associations are described or mentioned.

Introducción

Los autores han estudiado la estructura fisionómica y la composición floristica-fitocenológica de los tipos y asociaciones más frecuentes e importantes de la vegetación de Cuba, durante los ultimos 10 años. Establecieron las unidades básicas y superiores más comunes y distribuidas de la vegetación cubana y las clasificaron en el sistema fitocenológico. Como resultado de estos trabajos se publica la primera revista sistematica de las unidades superiores fitocenológicas (clases, ordenes, alianzas) junto con una descripción breve y caracterización floristica-fitosociológica de cada una y acompañada por la enumeración de los nombres de las asociaciones estudiadas pertenecientes a las distintas unidades superiores. La revista sistemática incluye 27 clases, 53 ordenes, 80 alianzas y más de 180 asociaciones fitocenológicas enumeradas. La mayoria de ellas son nuevas para la ciencia y estan descritas por primera vez en las páginas siguientes. Hay que mencionar, que una gran parte de las unidades superiores no se hallan solo en Cuba, sino tienen una distribución mas extensa, y estan representadas por las mismas u otras asociaciones en las demás Antillas, en las Bahamas, en Florida, en Yucatán, en América Central, en la parte Norte de América del Sur, en distintas partes de la area del Caribe, y algunas tienen una distribución neotropical. Esta clasificación se construye primeramente sobre la de Knapp (1964, 1965) y utiliza los resultados fitocenológicos de Cuatrecasas, Chapman, Ciferri, Hadač, Gómez-Pompa, Dansereau, Moncada, Samek, Schubert, Stehlé, Stoffers, Smith y otros, y representa el primer intento para sumar los conocimientos actuales sobre la vegetación cubana en una forma sistemática.

La primera versión de esta clasificación fue confeccionada por A. Borhidi en su tésis de DSc (1973) en base a su trabajo de mapificación de la vegetación de Cuba, realizado con la

co-autoridad de O. MUÑIZ, pero esta versión se quedó en manuscrito. En los años 1974—1978, los trabajos de mapificación de la Ciénaga de Zapata (realizado por E. DEL RISCO y A. BORHIDI) y la de la Sierra del Rosario (realizado por R. CAPOTE y A. BORHIDI) resultaron gran cantidad de conocimientos fitocenológicos nuevos y mas profundos, que nos permitieron ampliar y precisar la versión anterior en la forma siguiente.

Las unidades de la vegetación de Cuba

1. Clase: **SALVINIO-EICHHORNIETEA** Borhidi y Del Risco cl. n.

(Syn.: *Cabombo-Eichhornietea* Knapp 64 p.p.) Vegetación acuática libremente flotante en las aguas dulces neotropicales, especialmente en América Central, en las Antillas y en la parte Norte de América del Sur.

Espécies caracteristicas: *Salvinia auriculata*, *S. rotundifolia*, *Azolla caroliniana*, *Leman minima*, *L. perpusilla*, *Eichhornia crassipes*, *E. azurea*, *E. heterosperma*, *E. diversifolia*, *Pistia stratiotes*, *Aldrovanda vesiculosa*, *Utricularia* espéc. div.

1.1. Orden: SALVINIO-EICHHORNIETALIA Borhidi ord. n.

Vegetación acuática libremente flotante en la superficie de las aguas dulces neotropicales, o emergiendo por la mayor parte del cuerpo de las plantas. Mayormente comunidades de aguas eutróficas.

Espécies caracteristicas: *Salvinia auriculata*, *S. rotundifolia*, *Azolla caroliniana*, *Lemna* espéc. div., *Eichhornia* espéc. div., *Pistia stratiotes.*

1.1.1. Alianza: ***Azollaeo-Salvinion*** Borhidi y Muñiz al. n.

Vegetación acuática libremente flotante, formada por espécies de pequeño tamaño, cubriendo la superficie de las aguas dulces de las lagunas, mas raramente de los arroyos y rios lentamente corrientes.

Asociaciones estudiadas en Cuba:

Lemno-Azolletum carolinianae Borhidi y Muñiz ass. n.
Salvinietum auriculatae Borhidi y Muñiz ass. n.

1.1.2. Alianza: ***Eichhornion azureae*** Borhidi y Muñiz al. n.

Vegetación acuática flotante de plantas de mayor tamano, emergidas, no radicantes, formando céspedes densos flotantes sobre la superficie de las lagunas eutróficas u oligotróficas y en las zonas sublitorales de los corrientes lentos de los rios.

Asociaciones estudiadas u observadas en Cuba:

Eichhornietum crassipedis Samek y Moncada 1971
Pistietum stratiotidis Ciferri 1936
Eichhornietum azureae Borhidi ass. n.

1.2. Orden: ALDROVANDO-UTRICULARIETALIA Borhidi ord. n.

Vegetación acuática flotante formada por plantas sumergidas, no radicantes, mayormente carnívoras, que viven ligeramente sumergidas bajo la superficie de las aguas dulces eutróficas o mas a menudo distróficas de las lagunas pantanosas o cenagosas.

Espécies caracteristicas: *Aldrovanda vesiculosa, Utricularia foliosa, U. juncea, U. brevicarpa, U. sclerocarpa, U. stellaris, U. cornuta, U. resupinata, U. olivacea, U. incisa, U. purpurea, U. virgatula* etc.

1.2.1. Alianza: ***Aldrovando-Utricularion*** Borhidi al. n.

Carácteres del orden. Asociaciones estudiadas y observadas en Cuba:

Utricularietum foliosae Borhidi ass. n.
Utricularietum junceae Borhidi ass. n.

1.3. Orden: MAYACETALIA FLUVIATILIS Borhidi ord. n.

Vegetación acuática sumergida, a veces amfíbica, formada por céspedes densos de plantas musciformes en aguas corrientes frescas (arroyos montanos) o en lagunas oligotróficas. Distribución neotropical.

Espécies caracteristicas: *Mayaca fluviatilis, M. fluviatilis* ssp. *wrightii.*

1.3.1. Alianza: ***Mayacion fluviatilis*** Borhidi al. n.

Carácteres del orden. Asociaciones observadas o estudiadas en Cuba:

Mayacetum fluviatilis Borhidi ass. n.
Mayacetum wrightii Borhidi ass. n.

2. Clase: **CABOMBO-NYMPHAEETEA** Borhidi y Del Risco cl. n.

(Syn.: *Cabombo-Eichhornietea* Knapp 1964 p.p.) Vegetación acuática neotropical formada por plantas arraigadas en el fondo de las aguas dulces, sumergidas o emergidas, que se hallan en varias asociaciones en todos los tipos (eutróficas, oligotróficas y distróficas) de aguas dulces.

Espécies caracteristicas: *Brasenia peltata, B. schreberi, Cabomba aquatica, C. piauhiensis, Hydrocotyle umbellata, Nymphaea* espéc. div., *Potamogeton* espéc. div., *Myriophyllum verticillatum, Nymphoides* espéc. div.

2.1. Orden: CABOMBO-NAJADETALIA Borhidi y Del Risco ord. n.

(Syn.: *Utriculario-Najadetalia* Knapp 1964 p.p.) Vegetación acuática neotropical de plantas sumergidas y arraigadas en las aguas dulces immóviles o lentamente corrientes, a veces también en aguas ligeramente salobres.

Espécies caracteristicas: *Cabomba* espéc. div., *Ceratophyllum demersum, Myriophyllum pinnatum, M. sparsiflorum, Najas marina, N. guadelupensis* = *N. microdon, Vallisneria americana, V. neotropicalis.*

2.1.1. Alianza: ***Vallisnerion americanae*** Borhidi y Del Risco al. n.

Vegetación acuática neotropical de plantas sumergidas de hojas anchas, formando céspedes subacuáticas densas en las aguas dulces ligeramente distróficas, a veces salobres.

Asociaciones estudiadas en Cuba:

Vallisnerietum americanae Borhidi y Muñiz ass. n.
Vallisnerietum neotropicalis Borhidi y Del-Risco ass. n.

2.1.2. Alianza: ***Ceratophyllo-Cabombion piauhiensis*** Samek y Moncada 1971

Vegetación acuática neotropical de plantas sumergidas o por parte emergidas de hojas pinnati- o palmatisectas en las aguas dulces immóviles eutróficas u moderadamente oligotróficas.

Asociaciones estudiadas en Cuba:

Cabombetum piauhiensis Borhidi y Muñiz ass. n.
Nymphaeo-Cabombetum piauhiensis Samek y Moncada 1971

2.2. Orden: NYMPHAEETALIA AMPLAE Knapp 1964

Vegetación acuática caribeña de plantas arraigadas y emergidas, mayormente de hojas grandes, flotantes en la superficie o emergidas, en aguas dulces eutróficas, oligotróficas y ligeramente distróficas de poca profundidad.

Espécies caracteristicas: *Brasenia schreberi, Nymphaea ampla, N. blanda, Nuphar advena, Hydrocotyle umbellata, Nelumbo lutea, Nymphoides humboldtiana, N. grayana, Potamogeton* espéc. div.

2.2.1. Alianza: ***Potamion illinoisensis*** Borhidi al. n.

Vegetación acuática poco emergida, mayormente de aguas eutróficas, formando céspedes ± densas.

Espécies caracteristicas: *Potamogeton illinoisensis, P. malainus, P. nodosus, Hydrocotyle umbellata, Myriophyllum sparsiflorum.*

Asociaciones estudiadas en Cuba:

Potametum illinoisensi-nodosi Borhidi y Muñiz ass. n.
Potametum nodosi-malaini Borhidi y Muñiz ass. n.
Hydrocotyletum umbellati Del Risco ass. n.
Myriophylletum sparsiflori Borhidi ass. n.

2.2.2. Alianza: ***Nelumbio-Nymphaeion amplae*** Samek y Moncada 1971

Vegetación acuática emergida formada por plantas de hojas grandes y de flores grandes vistosas, mayormente en las aguas dulces distróficas y oligotróficas.

Asociaciones estudiadas u observadas en Cuba:

Brasenietum schreberi Borhidi ass. n.
Nymphaeetum amplae Ciferri 1936
Najadeto-Nymphaeetum amplae Del Risco ass. n.
Nupharetum advenae Borhidi y Del Risco ass. n.
Nelumbonetum luteae Samek y Moncada 1971
Eichhornio heterospermae-Nymphoidetum aureae Samek y Moncada 1971
Nymphoidetum grayanae Borhidi ass. n.
Polygonetum densiflori Borhidi ass. n.

2.2.3. Alianza: ***Crino-Limnocharion flavae*** Borhidi all. n.

Vegetación acuática emergida de aguas corrientes lentas y poco profundas, formando céspedes densos en las orillas de arroyos y rios pequeños.

Espécies caracteristicas: *Crinum americanum*, *C. oliganthum*, *Limnocharis flava*, *Fuirena umbellata*, *Rhynchospora* espéc. div.

Asociaciones estudiadas en Cuba:

Limnocharetum flavae Borhidi ass. n.

3. Clase: **CLADIETEA JAMAICENSIS** Knapp 1964

Herbazales altas y cañadas pantanosas o cenagosas en las zonas de inundaciones regulares, aluviales y en las orillas de rios de América Central y de las Antillas.

3.1. Orden: GYNERIO-BAMBUSETALIA Borhidi ord. n.

Cañadas altas de 3—10 m de altura, monodominantes, formadas por pocas espécies, distribuidas mayormente a lo largo de las orillas de los arroyos y rios.

Espécies caracteristicas: *Gynerium sagittatum*, *Bambusa vulgaris* (naturalizada), *Arundo donax* etc.

3.1.1. Alianza: ***Gynerion sagittati*** Borhidi al. n.

Caracteres del orden. Asociaciones estudiadas en Cuba:

Gynerietum sagittati Borhidi ass. n.

3.2. CYPERO HETEROPHYLLI-PENNISETETALIA Borhidi ord. n.

Cañadas y herbazales secondarios en las orillas pedregosas de los arroyos y rios montanos y submontanos.

Espécies caracteristicas: *Cyperus heterophyllus*, *C. surinamensis*, *Pennisetum purpureum*, etc.

3.2.1. Alianza: ***Cyperion heterophylli*** Borhidi al. n.

Caracteres del orden, con varias asociaciones secundarias en Cuba y en las demás Antillas.

3.3. Orden: SCIRPO-ELEOCHARIETALIA INTERSTINCTAE Borhidi y Muñiz ord. n.

Herbazales altas pantanosas de aguas dulces mayormente eutróficas u oligotróficas o ligeramente salobres, en las orillas de lagunas cenagosas y pantanosas, periodicamente inundadas, sin acumulación de turba eb el suelo.

Espécies caracteristicas: *Scirpus validus*, *S. olneyi*, *Eleocharis interstincta*, *E. cellulosa*, *Cyperus articulatus*, *C. diffusus*, *C. swartzii*, *Sagittaria lancifolia*, *S. intermedia*, *Echinodorus* espéc. div., *Pontederia lanceolata*, *Paspalidium paludivagum*, *Panicum aquaticum*, *P. lacustre*, *Rhynchospora corniculata*, *R. gigantea* etc.

3.3.1. Alianza: ***Sagittario-Eleocharion interstinctae*** Borhidi y Del Risco al.n.

Herbazales pantanosos altos en aguas eutróficas o ligeramente salobres. Espécies caracteristicas del orden.

Asociaciones estudiadas y observadas en Cuba:

Sagittario-Eleocharetum interstinctae Del Risco ass. n.
Paspalidietum paludivagi Del Risco y Borhidi ass. n.
Eleocharetum cellulosae Borhidi ass. n.
Cyperetum articulati Borhidi ass. n.
Scirpetum olneyi Borhidi ass. n.
Scirpetum validi Borhidi et Muñiz ass. n.

3.4. Orden: TYPHETO-CLADIETALIA JAMAICENSIS Borhidi y Del Risco ord. n.

(Syn.: *Pontederio-Cladietalia* Knapp 1964 y *Rhynchosporeto-Cladietalia* Knapp 1964) Cañadas y herbazales altos cenagosos, por lo común permanentemente inundados, con acumulación de turba en el suelo.

3.4.1. Alianza: ***Typhion domingensis*** Del Risco al. n.

Cañadas cenagosas.

Espécies caracteristicas: *Typha domingensis*, *Phragmites australis*, *Cladium jamaicense*, *Pontederia lanceolata*, *Fuirena umbellata*, *Cyperus giganteus*, *Thalia geniculata*.

Asociaciones estudiadas u observadas en Cuba:

Typhetum domingensis Borhidi y Muñiz ass. n.
Cyperetum gigantei Borhidi ass. n.
Polygoneto-Thalietum geniculatae Borhidi ass. n.

3.4.2. Alianza: ***Cladion jamaicensis*** Borhidi y Muñiz al. n.
Herbazales cenagosas altas en aguas distróficas, mayormente en suelos turbosos.

Espécies caracteristicas: *Cladium jamaicense, Crinum americanum, C. oliganthum, Paspalum giganteum, Dichromena colorata, Panicum lancearium, P. condensum, P. virgatum, Andropogon glomeratus, Centella erecta, Erianthus giganteus, Rhynchospora cyperoides, Sacciolepis striata, Solidago stricta, Thelypteris palustris.*

Asociaciones estudiadas en Cuba:

Crino-Cladietum jamaicensis Borhidi y Muñiz ass. n.

4. Clase: **PARVIRHYNCHOSPORETO-ERIOCAULETEA** Borhidi cl. n.

Herbazales bajos y enanos, en lugares húmedos o pantanosos, mayormente oligotróficos, sobre suelos ácidos y pobres en nutrientes, más frecuentemente sobre arenas blancas húmedas, temporalmente inundadas por aguas de poca profundidad. La vegetación esta formada por ciperáceas pequeñas (*Eleocharis* y *Rhynchosporas* enanas), Xyridáceas, Eriocauláceas, Escrofulariáceas y Rubiáceas enanas y rastreras y algunas plantas carnivoras, como *Utricularias* arraigadas enanas, *Pinguicula filifolia, Drosera intermedia*, además *Hyptis pedalipes, Aster grisebachii, Stenandrium ovatum, Rhexia cubensis, Lachnorrhiza piloselloides.*

4.1. Orden: RHYNCHOSPORETO-XYRIDETALIA Borhidi ord. n.
Herbazales oligotróficos humedos o pantanosos formados por céspedes bajos y cerrados.

Espécies caracteristicas: *Rhynchospora cyperoides, R. filifolia, R. tenuis, R. tracei, Acisanthera quadrata, Chaetolepis cubensis, Eleocharis capillacea, Herpyza grandiflora, Lachnocaulon ekmanii, Lachnanthes tinctoria, Panicum lancearium, P. wrightianum, Scleria* espéc. div., *Xyris navicularis, X. elliottii, X. flexuosa*, etc.

4.1.1. Alainza: ***Rhynchosporeto-Xyridion*** Borhidi al. n.
Carácteres del orden. Asociaciones observadas y estudiadas en Cuba:

Xyridi-Hypericetum fasciculati Borhidi ass. n.
Chaetolepidi-Rhynchosporetum Borhidi ass. n.

4.2. Orden: PAEPALANTHO-ERIOCAULETALIA Knapp 1964 em. Borhidi

Herbazales pantanosos oligotróficos, periodicamente secos; céspedes abiertos formados por plantas perennes enanas y acolchonadas, esencialmente sobre arenas blancas o mas raramente sobre serpentinas o lateritas humedas, todos pobres en nutrientes.

Espécies caracteristicas: *Eriocaulon arenicola*, *E. fuliginosum*, *E. insulare*, *E. ovoideum*, etc., *Paepalanthus alsinoides*, *P. seslerioides*, *P. lamarckii*, *P. rivularis*, *Syngonanthus androsaceus*, *S. insularis*, *S. lagopodioides*, *S. leonis*, *S. wilsonii*, *Xyris ekmanii*, *Scleria* espéc. div., *Richardsonia* espéc. div., *Mitracarpus depauperatus*, etc.

4.2.1. Alianza: ***Eriocaulo-Paepalanthion*** Borhidi al. n.

Carácteres del orden. Asociaciones observadas y estudiadas en Cuba:

Syngonantho-Paepalanthetum alsinoidis Borhidi ass. n.
Xyridi-Paepalanthetum seslerioidis Borhidi ass. n.

5. Clase: **ZOSTERETEA** Chapman 1974

Céspedes submarinos arraigados y vegetación acuática sumergida de las aguas saladas formada por plantas fanerógamas, de gran distribución, mayormente pantropicales.

5.1. Orden: RUPPIETALIA MARITIMAE J. Tx. 1960.

Céspedes submarinos de la región templada y vegetación de las lagunas saladas continentales e insulares.

Espécies caracteristicas: *Ruppia maritima*, *Najas marina*, *N. wrightii*, *Halodule beaudetii*, *H. wrightii*.

5.1.1. Alianza: ***Ruppion maritimae*** Br.-Bl. 1931

Asociaciones observadas y estudiadas en Cuba:

Ruppietum maritimae tropicalis Borhidi y Del Risco var. n.

5.2. Orden: THALASSIO-SYRINGODIETALIA FILIFORMIS Knapp 1964

Céspedes submarinos tropicales de la región del Caribe.

Espécies caracteristicas: *Thalassia testudinum*, *Syringodium filiforme*, *Diplanthera* = *Halodule wrightii*, *Halophila baillonis*, *H. aschersonii*, *Hydromistria stolonifera*.

5.2.1 Alianza: ***Syringodio-Thalassion*** Borhidi al. n.

Carácteres del orden. Asociaciones observadas y estudiadas en Cuba:

Syringodio-Thalassietum Ciferri 1936
Hydromistrietum stoloniferae Borhidi ass. n.

6. Clase: **IPOMOEO-MALLOTONIETEA** Knapp 1964 em. Borhidi

(Syn.: *Ipomoeo-Tournefortietea* Knapp 1964 p.p.) Vegetación herbácea y suffruticosa de las playas arenosas, distribuida en todos los trópicos.

6.1. Orden: CANAVALIO-IPOMOEETALIA Knapp 1964 em. Borhidi
Vegetación pionera, abierta de las playas arenosas.

Espécies caracteristicas: *Canavalia maritima*, *Ipomoea pes-caprae*, *I. alba*, *Cakile maritima*, *Cenchrus tribuloides*, *Diodia maritima*, *Philoxerus vermicularis*, *Sporobolus virginicus*, *Stemodia maritima*, etc.

6.1.1. Alianza: ***Ipomoeo-Canavalion maritimae*** Borhidi al. n.
Carácteres del orden. Asociaciones estudiadas en Cuba:

Sesuvio-Ipomoeetum pes-caprae Borhidi ass. n.
Philoxero-Unioletum virgatae Borhidi ass. n.
Ipomoeo-Philoxeretum vermicularis Ciferri 1936

6.2. Orden: BORRICHIO-MALLOTONIETALIA Borhidi ord. n.
Céspedes cerrados y matorrales bajos costeros de las playas arenosas.

Espécies caracteristicas: *Borrichia arborescens*, *B. cubana*, *Tournefortia* = *Mallotonia gnaphalodes*, *Distichlis spicata*, *Ernodea littoralis*, *Suriana maritima*, *Scaevola plumieri*, *Erithalis fruticosa*, *Spartina juncea*, *Uniola virgata*, *Casasia clusioides*, etc.

6.2.1. Alianza: ***Borrichio-Mallotonion*** Borhidi al. n.
Céspedes cerrados de las playas arenosas. Asociaciones estudiadas en Cuba:

Borrichio-Mallotonietum Borhidi ass. n.
Sporobolo-Spartinetum junceae Ciferri 1936
Turnereto-Unioletum virgatae Ciferri 1936

6.2.2. Alianza: ***Suriano-Baccharidion halimifoliae*** Borhidi al. n.
Matorrales costeros de las playas arenosas.
Asociaciones estudiadas en Cuba:

Ernodeo-Surianetum Ciferri 1936
Suriano-Baccharidetum halimifoliae Borhidi ass. n.

7. Clase: **SESUVIO-RHACHICALLIDETEA** Borhidi cl. n.

Vegetación orófila de las costas rocosas de la región del Caribe

7.1. Orden: TRIANTHEMO-SESUVIETALIA Borhidi ord. n.
Vegetación pionera abierta de las costas rocosas, formadas mayormente por plantas rastreras suculentas.

Espécies caracteristicas: *Sesuvium portulacastrum*, *S. maritimum*, *Trianthema portulacastrum*, *Lithophila muscoides*, etc.

7.1.1. Alianza: ***Trianthemo-Sesuvion*** Borhidi al. n.
Carácteres del orden. Asociaciones estudiadas en Cuba:

Lithophilo-Trianthemetum portulacastri Borhidi ass. n.
Trianthemo-Sesuvietum portulacastri Borhidi ass. n.

7.2. Orden: BORRICHIO-RHACHICALLIDETALIA Borhidi ord. n.
Vegetación moderadamente cerrada de las costas rocosas formadas mayormente por plantas acolchonadas, sufrutices y arbustos.

Espécies caracteristicas: *Rhachicallis americana*, *Borrichia arborescens*, *B. cubana*, *Conocarpus erecta* f. *caespitosa*, *Heliotropium humifusum*, *Chamaesyce buxifolia*, *Pectis* espéc. div., *Strumpfia maritima*, *Erithalis vacciniifolia*, *Flaveria lineata*, *Opuntia dillenii* s.l., etc.

7.2.1. Alianza: ***Borrichio-Rhachicallion*** Borhidi al. n.
Carácteres del orden. Asociaciones observadas y estudiadas en Cuba:

Sesuvio-Rhachicallidetum americanae Borhidi ass. n.
Conocarpo-Rhachicallidetum americanae Borhidi ass. n.
Borrichio-Rhachicallidetum (Uphof 1924) Ciferri 1936
Erithali-Strumpfietum Borhidi ass. n.

8. Clase: **BATIDI-SALICORNIETEA** Knapp 1964

Vegetación de las salinas formada por plantas suculentas y gramíneas de alta tensión osmótica. Esta zona se desarrolla mayormente detrás de las zonas del manglar, donde los suelos estan inundados dos veces al año y por las secas estacionalmente repetidas el sal se acumula en el horizonte superior, y la concentración alta del sal no permite la formación de una vegetación boscosa.

8.1. Orden: BATIDI-SALICORNIETALIA AMBIGUAE Knapp 1964
Vegetación de salinas formada mayormente por plantas suculentas.

Espécies caracteristicas: *Batis maritima*, *Salicornia ambigua*, *S. perennis*, *Suaeda fruticosa*, *S. linearis*, *Fimbristylis spathacea*, etc.

8.1.1. Alianza: ***Fimbristyli-Salicornion perennis*** Chapman 1960
Vegetación sufrutescente abierta de las salinas. Asociaciones estudiadas en Cuba:

Fimbristylieto-Salicornietum perennis Borhidi ass. n.

8.1.2. Alianza: ***Batidion maritimae*** Borhidi al. n.
Vegetación sufrutescente cerrada de las salinas.
Asociaciones observadas y estudiadas en Cuba:
Batidetum maritimae Ciferri 1936

8.2. Orden: DISTICHLIO-SPARTINETALIA (Chapman 1974) Borhidi y Del Risco
Vegetación de las salinas formadas por céspedes de gramíneas y ciperáceas de alta tensión osmótica.

Espécies caracteristicas: *Distichlis spicata, Spartina juncea, Sporobolus virginicus* ssp. *littoralis, Chloris sagraeana, Eragrostis salzmannii, Heliotropium curassavicum, Philoxerus vermicularis*, etc.

8.2.1. Alianza: ***Distichlion spicatae*** (Chapman 1960) Borhidi y Del Risco
Carácteres del orden. Asociaciones estudiadas en Cuba:

Distichlietum spicatae Ciferri 1936

9. Clase: **RHIZOPHORO-AVICENNIETEA GERMINANTIS** Knapp 1964 em. Borhidi y Del Risco
Manglares de los Neotrópicos.

9.1. Orden: RHIZOPHORETALIA Cuatrecasas 1958
Manglares permanentemente inundadas con raizes aereas y con viviparismo.

9.1.1. Alianza: ***Rhizophorion occidentalis*** Cuatrecasas 1958
Espécies caracteristicas: *Rhizophora mangle.*
Asociaciones estudiadas en Cuba:

Rhizophoretum manglis Cuatrecasas 1958

9.2. Orden: AVICENNIETALIA Cuatrecasas 1958
Manglares inundadaspor ondas bajas y no permanentes, lo que permite la aeración de las raices mediante neumatóforos.

9.2.1. Alianza: ***Avicennion occidentalis*** Cuatrecasas 1958

Espécies caracteristicas: *Avicennia germinans, Batis maritima, Rhabdadenia biflora, Lycium tweedianum*, etc.

Asociaciones estudiadas en Cuba:

Rhizophoro-Avicennietum germinantis Borhidi y Muñiz ass. n.
Batidi-Avicennietum germinantis Borhidi y Del Risco ass. n.

9.3. Orden: COMBRETALIA Cuatrecasas 1958

Manglares estacionalmente inundadas, en suelos fangosos, muy salados con o sin neumatóforos.

9.3.1. Alianza: ***Conocarpo-Lagunculario***n (Cuatrecasas 1958) Borhidi

Espécies caracteristicas: *Conocarpus erecta*, *Laguncularia racemosa*, *Acrostichum aureum*, *A. danaifolium*, etc.

Asociaciones observadas o estudiadas en Cuba:

Conocarpo-Laguncularietum racemosae Del Risco ass. n.
Acrosticho-Conocarpetum erectae (Bonazzi 1937) Borhidi y Del Risco

10. Clase: **CHRYSOBALANO-ANNONETEA GLABRAE** Borhidi y Muñiz cl. n.

Bosques y matorrales sobre suelos pantanosos y cenagosos, siempreverdes a deciduos de habitades permanentemente húmedas; se desarrollan en las cuencas de mal drenaje, en orillas de lagunas y de mayores rios y en las zonas subcosteras bajas, periodicamente inundadas en la estación de lluvia. Se distribuyen en todas las Antillas, en Florida, en las costas caribeñas de México, América Central y América del Sur.

Espécies caracteristicas: *Chrysobalanus icaco*, *Annona glabra*, *Myrsine cubana*, *M. guianensis*, *Bucida buceras*, *B. spinosa*, *B. palustris*, *Bucida subinermis*, *Metopium brownei*, *Pterocarpus officinalis*, *Sterculia caribaea*, *Acoelorraphe wrightii*, *Copernicia glabrescens*, *Dryopteris patens*, *D. serra*, *Osmunda regalis*, etc.

10.1. Orden: CHRYSOBALANO-ANNONETALIA GLABRAE Borhidi y Del Risco ord. n.

Matorrales o bosques bajos pantanosos, estacionalmente inundados por aguas profundas dulces, distróficas, oligotróficas o poco salobres.

10.1.1. Alianza: ***Chrysobalano-Annonion glabrae*** Borhidi y Muñiz al. n.

Matorrales pantanosos o cenagosos estacionalmente inundados, con una economía de agua extrema. Comunidades con un aspecto permanente o dos aspectos alternantes, uno acuático de verano y otro sabanoso de invierno.

Asociaciones estudiadas en Cuba:

Chrysobalano-Annonetum glabrae Ciferri 1936
Osmundo-Chrysobalanetum icaconis Borhidi ass. n.
Copernicio-Bucidetum spinosae Borhidi y R. Capote ass. n.

10.1.2. Alianza: ***Salicion carolinianae*** Del Risco al. n.

Bosques bajas monodominantes, permanentemente humedas en las orillas de lagunas dulces o ligeramente salobres. Comunidades pobres en espécies.

Espécies caracteristicas: *Salix caroliniana*, *Myrica cerifera*, *Dalbergia ecastophyllum*, *D. monetaria*, etc.

Asociaciones estudiadas en Cuba:

Salicetum carolinianae Del Risco ass. n.

10.2. Orden: TABEBUIO-BUCIDETALIA (Lvov 1967) Borhidi y Del Risco ord. n.

Bosques de ciénaga inundados en casi todo el transcurso del año por aguas dulces o ligeramente salobres. Suelo mayormente una turba ± profunda, frecuentemente gleyzado, a veces el subsuelo es pedregoso de la caliza costera, la que esta cubierta por una capa de suelo gleyzado poco profundo. El estrato arbóreo de 6—20 m alto, con un estrato arbustivo desarrollado.

Espécies caracteristicas: *Tabebuia angustata*, *Bucida palustris*, *B. subinermis*, *Fraxinus caroliniana* ssp. *cubensis*, *Manilkara wrightii*, *Ilex cassine*, *Myrsine cubana*, *Xylopia obtusifolia*, *Guettarda combsii*, *Sabal parviflora*.

10.2.1. Alianza: ***Tabebuio-Bucidion*** Borhidi y Del Risco al. n.

Carácteres del orden. Asociaciones estudiadas en Cuba:

Bucido-Fraxinetum cubensis Borhidi y Del Risco ass. n.
Rhizophoro-Chrysobalanetum icaconis Del Risco y Borhidi ass. n.
Conocarpo-Bucidetum palustris Borhidi y Del Risco ass. n.
Tabebuio-Bucidetum palustris Borhidi y Del Risco ass. n.

11. Clase: **SWIETENIO-BROSIMETEA** Knapp 1964

Pluvisilvas de las llanuras y de las alturas bajas y medianas (en Cuba hasta 800 m) con 3 estratos arbóreos o 2 estratos con emergentes, siempreverdes o a veces con algunos emergentes deciduos. Lianas, epífitos y epífilos escasos, o no muy abundantes.

11.1. Orden: DIPHOLI-CALOPHYLLETALIA Knapp 1964

Pluvisilvas submontanas (en Cuba entre 250 y 800 m de altura), condicionadas por un clima permanentemente húmedo, con 0—1 mes seco y mas de 2000 mm de lluvia anual.

11.1.1. Alianza: ***Calophyllo-Dipholion*** Borhidi al. n.

Pluvisilvas submontanas de las Antillas Mayores. En Cuba estan representadas en la provincia de Oriente.

Espécies caracteristicas en Cuba: *Dipholis jubilla*, *D. ekmanii*, *Calophyllum utile*, *Carapa guianensis*, *Ochroma pyramidalis*, *Terminalia maestrensis*, *Zizyphus rhodoxylon*, *Ficus* espéc. div., *Manilkara albescens*, *Bactris cubensis*, *Cordia sulcata*, *Miconia elata*, *Heliconia caribaea*, *Oxandra laurifolia*, *Columnea* spp., *Hillia* spp., *Psychotria nutans*, *Phaius tankervilliae*, etc.

Asociaciones estudiadas en Cuba:

Calophyllo-Carapetum guianensis Borhidi y Muñiz ass. n.
Oxandro-Dipholietum jubillae Borhidi ass. n.

11.1.2. Alianza: ***Alchorneo-Pseudolmedion spuriae*** Borhidi al. n.

Bosque siempreverdes estacionales submontanas en Cuba Central y Occidental, Yucatán y Norte de América Central, entre 300 y 800 m de altura.

Espécies caracteristicas en Cuba: *Matayba oppositifolia*, *Alchornea latifolia*, *Pseudolmedia spuria*, *Trophis racemosa*, *Margaritaria nobilis*, *Tabebuia shaferi*, *Antirhea radiata*, *Sloanea amygdalina*, *Oxandra lanceolata*, *Dendropanax arboreus*, *Mastichodendron foetidissimum*, *Zanthoxylum martinicense*, etc.

Asociaciones estudiadas en Cuba:

Mataybeto-Pseudolmedietum spuriae Borhidi y R. Capote ass. n.

12. Clase: **CEIBETEA OCCIDENTALIS** Knapp 1964

Bosques siempreverdes estacionales de las llanuras y zonas colinosas de la región del Caribe bajo un clima estacional con 2—4 meses secos y 1400—2000 mm de lluvia anual. Estratos arbóreos 2, con emergentes mayormente deciduos, con muchas lianas macrófilas, epifitos xerofiticos (*Tillandsia* spp.).

Espécies caracteristicas en Cuba: *Ceiba pentandra*, *Guazuma ulmifolia*, *Luehea speciosa*, *Calycophyllum candidissimum*, *Cedrela mexicana*, *C. cubana*, *Swietenia mahagoni*, *Hibiscus elatus*, *Calophyllum antillanum* ssp. *antillanum*, *Cupania glabra*, *Lonchocarpus domingensis*, *L. latifolius*, *Roystoea regia*, *Dipholis salicifolia*, *Mastichodendron foetidissimum*, etc.

12.1. Orden: LONCHOCARPO-CEIBETALIA Borhidi y Muñiz ord. n.

Bosques siempreverdes estacionales de las llanuras y cuencas pantanosas en las Antillas con 2 estratos arbóreos con algunos elementos deciduos. Espécies caracteristicas del orden (enumeradas en la clase).

12.1.1. Alianza: ***Guazumo-Cupanion*** Borhidi y Del Risco al. n.

Bosques siempreverdes estacionales meso-macrófilos con pocos elementos deciduos.

Asociaciones estudiadas en Cuba:

Hibisco-Calophylletum antillanae Del Risco ass. n.
Guazumo-Ceibetum Borhidi ass. n.

Spondiato-Roystonietum Ciferri 1936 (secundaria)
Mastichodendro-Dipholietum salicifoliae Borhidi y Muñiz ass. n.

12.1.2. Alianza: ***Hibisco-Swietenion mahagoni*** Del Risco y Borhidi al. n.
Bosques siempreverdes estacionales de las cuencas pantanosas regularmente inundadas, con elementos noto-micrófilos y deciduos.
Asociaciones estudiadas en Cuba:

Lysilomo-Metopietum brownei Borhidi y Del Risco ass. n.
Calophyllo-Swietenietum mahagoni Del Risco ass. n.

12.2. Orden: OXANDRO-BURSERETALIA Borhidi y Muñiz ord. n.
Bosques semideciduos de las Antillas con 2 estratos arbóreos; el superior de hasta 20—25 m de altura, formado mayormente por árboles deciduos. Comunidades muy comunes en las zonas llanas y colinosas, bajo un clima estacional con 3—6 meses secos y 800—1600 mm de lluvia anual. Suelos mayormente calizas pedregosas moderadamente profundas.

Espécies caracteristicas en Cuba: *Bursera simaruba*, *Spondias mombin*, *Andira inermis*, *Cordia collococca*, *C. gerascanthus*, *Celtis trinervia*, *Zanthoxylum elephantiasis*, *Casearia hirsuta*, *C. spinescens*, *Jacaranda coerulea*, *Pithecellobium cubense*, *Samanea saman*, *Buchenavia capitata*, *Amyris elemifera*, etc.

12.2.1. Alianza: ***Oxandro-Burserion*** Borhidi y Muñiz al. n.
Carácteres del orden. Asociaciones estudiadas en Cuba:

Mastichodendro-Burseretum Borhidi y Muñiz ass. n.
Zanthoxylo-Burseretum Borhidi ass. n.
Mastichodendro-Trichilietum hirtae Schubert et al. 1979.

13. Clase: **TABEBUIO-BURSERETEA** Knapp 1964

Bosques y semidecidous deciduos o formados por elementos mayormente deciduos, con 1—2 estratos arbóreos; el superior formado por árboles deciduos, en el inferior se encuentran árboles deciduos o siempreverdes esclerófilos. Se distribuyen en las llanuras y zonas colinosas, mayormente sobre calizas pedregosas bajo un clima estacional marcadamente seco, con 5—7 meses secos o bajo un clima más húmedo, pero condicionados edáficamente en las areas de carso cónico (pié de mogotes), de carso subcostero (diente de perro) y en zonas arenosas.

Espécies caracteristicas: *Bursera simaruba*, *Gossypiospermum praecox*, *Cordia gerascanthus*, *Celtis trinervia*, *Hebestigma cubense*, *Lysiloma bahamensis*, *Catalpa punctata*, *Bombacopsis*

cubensis, *Hildegaardia cubensis*, *Tabebuia* espéc. div., *Piscidia* espéc. div., *Guettarda ovata*, *Drypetes* espéc. div., *Savia sessiliflora*, *Hypelate trifoliata*, *Pithecellobium lentiscifolium*, *Alvaradoa amorphoides* ssp. *psilophylla*, con algunas cactáceas en el sottobosque y muchas lianas.

13.1. Orden: TABEBUIO-BURSERETALIA Knapp 1964
Carácteres de la clase.

13.1.1. Alianza: ***Lysilomo-Burserion simarubae*** Borhidi al. n.
Bosques deciduos mesófilos subcosteros mayormente mas altos (15—20 m) con elementos siempreverdes.
Asociaciones estudiadas en Cuba:

Lysilomo-Burseretum simarubae Borhidi y Del Risco ass. n.

13.1.2. Alianza: ***Pithecellobion lentiscifolii*** Del Risco al. n.
Bosques deciduos micrófilos sobre diente de perro, mayormente de una altura de menos de 15 m., pobres en espécies.
Asociaciones estudiadas:

Spondiato-Pithecellobietum lentiscifolii Borhidi y Del Risco ass. n.

14. Clase: **COCCOTHRINACETO-PLUMERIETEA** Knapp 1964 em. Borhidi

Bosque arbustosos bajos por parte deciduos, ricos en lianas y en elementos siempreverdes esclerófilos, nominados en la literatura mayormente com "monte seco". Crecen mayormente sobre caliza erosionada, climáticamente condicionados, en las terrazas costeras y subcosteras y en los mogotes, bajo un clima estacional con 7—9 meses secos, frecuentemente bixérico, y 600—1200 mm de lluvia anual, o se hallan en climas mas húmedos monoxéricos, condicionados edáficamente en paredones y topes de carsos cónicos (mogotes).

KNAPP incluyó en esta clase los pinares arenosos y serpentinosos también, que obviamente ni por critérios fisionómicos ni por composición floristica pueden pertenecerse en esta unidad, sino representan una clase completamente distinta: *Byrsonimo-Pinetea*. Las comunidades de esta clase de distribuyen en las Antillas y Bahamas.

Espécies caracteristicas: *Coccothrinax* espéc. div., *Plumeria* espéc. div., *Bumelia* espéc, div., *Coccoloba diversifolia*, *Canella winterana*, *Omphalea* espéc. div., *Bursera simaruba*, *Ateramnus lucidus*, *Gyminda latifolia*, *Crossopetalum rhacoma*, *Eugenia maleolens*, *Amyris balsamifera*, *Tabebuia myrtifolia*, *Jacquinia brevifolia*, *J. keyensis*, *Guajacum officinale*, *G. sanctum*, *Erythroxylon* espéc. div., *Capparis* espéc div., *Malpighia* espéc. div., *Krugiodendron ferreum*, *Grimmeodendron eglandulosum*, *Thrinax* espéc. div., *Picrodendron* espéc. div., *Metopium brownei*, *Guapira* (*Torrubia*) espéc. div., *Lantana involucrata*, *Cordia* espéc. div., *Bourreria succulanta*, *Ficus jacquinifolia*, *Hippomane mancinella*, *Diospyros grisebachii*, *Selenicereus grandiflorus*, *Pilosocereus* espéc. div., *Dendrocereus nudiflorus*.

14.1. Orden: EUGENIO-METOPIETALIA TOXIFERI Knapp 1964
Bosques arbustosos subcosteros de las Antillas y Bahamas.

Espécies caracteristicas en Cuba: *Metopium brownei, M. toxiferum, Thrinax radiata. Coccothrinax borhidiana, C. litoralis, C. fragrans, Plumeria obtusa, P. keyensis, P. tuberculata, Omphalea trichotoma, Krugiodendron ferreum, Grimmeodendron eglandulosum, Picrodendron macrocarpum, Calyptranthes pallens, C. dodecandra, Colubrina arborescens, C. elliptica, C. cubensis, Guapira longifolia, Castela* espéc. div., *Coccoloba diversifolia, Dipholis salicifolia, Bumelia celastrina, B. glomerata* ssp. *horrida, Pouteria domingensis, Thouinia* espéc. div., *Croton lucidus.*

14.1.1. Alianza: ***Eugenio-Capparidion*** Borhidi al. n.

Bosques arbustosos subcosteros de las Antillas Mayores sobre caliza de madrepora en las terazas calizas cercanas a las costas. Se caracterizan por la participación de árboles deciduos y siempreverdes, palmas, de frutices siempreverdes por parte espinosos y de algunas cactáceas columnares o arborescentes y otros suculentas.

Espécies caracteristicas: *Capparis flexuosa, C. cynophallophora, Picrodendron macrocarpum, Colubrina elliptica, Hippomene mancinella, Tabebuia myrtifolia, Krugiodendron ferreum, Grimmodendron eglandulosum, Eugenia maleolens, Coccoloba diversifolia, Catalpa punctata, Bourreria succulenta, Cordia galeottiana, C. sebestena, Opuntia dillenii* s.l.

Asociaciones estudiadas en Cuba:

Picrodendro-Burseretum simarubae Del Risco ass. n.
Grimmeodendro-Gochnatietum sagraeanae Borhidi ass. n.
Krugiodendro-Drypetetum Ciferri 1936
Sarcomphalo-Reynosietum septentrionalis Borhidi ass. n.

14.2. Orden: BOMBACOPSI-THRINACETALIA Borhidi ord. n.

Bosques arbustosos secos, frecuentemente abiertos, de Cuba Occidental con palmas, árboles deciduos, xerofíticos o provistos de organos aptos para accumulación de agua, ricos en suculentas mayormente rastreras o rosuladas, y en lianas. El estrato herbáceo a menudo esta formado por bromeliáceas epifíticas.

Espécies caracteristicas: *Thrinax morrisii, Bombacopsis cubensis, Erythrina cubensis, Agave tubulata, Thouinia nervosa, Tabebuia anafensis, T. calcicola, Plumeria nervosa, Terminalia neglecta, Ateramnus brachypodus, Oplonia purpurascens, Leptocereus* espéc. div., *Vitex divaricata* ssp. *cubensis, Celtis iguanaea, Pristimera coriacea, Cuervea integrifolia, Psidium scopulorum, Rochefortia spinosa, Lantana strigosa, Malphigia roigiana.*

14.2.1. Alianza: ***Spathelio-Gaussion*** Borhidi al. n.

Bosques arbustosos de mogotes de Cuba Occidental, que crecen sobre caliza jurásica "azul" muy dura (Sierra de los Organos, Sierra de la Güira, Pan de Guajaibón). Sus composición floristica es muy rica en espécies con alto prociento de endémicos.

Espécies caracteristicas: *Spathelia brittonii*, *Gaussia princeps*, *Ceratopyxis verticillata*, *Bursera shaferi*, *Ekmanianthe actinophylla*, *Portlandia pendula*, *Guettarda calcicola*, *Eugenia galeata*, *E. cristata*, *Lobelia cubana*, *Tetrazygia lanceolata* s.l., *Lantana strigosa*, *Auerodendron acuminatum*, *Bourreria mucronata*, *B. polyneura*, *Leptocereus assurgens*, *L. ekmanii*, *Vriesea dissitiflora*, *Omphalea hypoleuca*, *Ancistranthus harpochiloides*.

Asociaciones estudiadas:

Ceratopyxi-Gaussietum principis Borhidi ass. n.
Vrieseo-Bombacopsidetum cubensis Borhidi ass. n.
Bombacopsi-Gaussietum principis Borhidi ass. n.

14.2.2. Alianza: ***Thrinacion morrisii*** Borhidi al. n.

Bosques arbustosos de mogotes sobre calizas blandas terciárias de Cuba Occidental (Sierra del Rosario, Sierra de Anafe, Mogotes de Tapaste y Jaruco, Alturas de Habana y Matanzas) pobres en espécies y con bajo porciento de endemicos.

Espécies caracteristicas: *Celtis trinervia*, *Cordia gerascanthus*, *Hebestigma cubense*, *Gossypiospermum praecox*, *Tabebuia myrtifolia*, *T. anafensis*, *Leptocereus leoni*, *Eugenia* espéc. div., *Tournefortia maculata*, *Ficus laevigata*, *Pseudocarpidium neglectum*, *Sapium leucogynum*, *Picramnia pentandra*, etc.

Asociaciones estudiadas:

Bombacopsi-Thrinacteum morrisii Borhidi et Muñiz ass. n.
Celtidi-Hebestigmentum cubensis Borhidi ass. n.

14.3. Orden: TABEBUIO-COCCOTHRINACETALIA Borhidi et Muñiz ord. n.

Bosques arbustosos de mogotes sobre calizas terciárias en las montañas de Cuba Central y Oriental (Sierra de Escambray, Sierra Maestra, Mogotes del Masizo Sagua-Baracoa) ricos en espécies y con alto porciento de endémicos; ricos en palmas, árboles y arbustos esclerófilos y lianas, a menudo con cactáceas columnares, pero sin bromeliáceas epifíticas en el estrato herbáceo, sino con una abundancia de Pileas.

Espécies caracteristicas: *Coccothrinax* espéc. div., *Hemithrinax compacta*, *Tabebuia* espéc. div., *Zanthoxylum coriaceum*, *Gesneria heterochroa*, *G. cubensis*, *Phyllanthus epiphyllanthus* ssp. *dilatatus*, *Neobracea susannina*, *N. howardii*, *Eupatorium carsticolum*, *Synapsis ilicifolia*, *Thouinia* espéc. div., *Euleria tetramera*, *Selenicereus urbanii*, *Marcgravia rectiflora*, *Savia erythroxyloides* var. *parvifolia*, *Garrya fadyenii*, *Pilea* espéc. div.

14.3.1. Alianza: ***Tabebuio-Coccothrinacion*** Borhidi y Muñiz al. n.

Bosques de mogotes representadas en areas mayormente aisladas por asociaciones vicariantes, compuestas de espécies distintas de mismos géneros, como *Coccothrinax*, *Tabebuia*, *Pilea*, *Gesneria*, *Thouinia* etc. En las cumbres mas elevadas los elementos de los bosques de mogote se entremesclan con

espécies de pluvisilvas montanas formando comunidades especiales de mogotes altos.

Asociaciones estudiadas:

Coccothrinacio-Tabebuietum albicantis Borhidi y Muñiz ass. n.
Tabebuio sauvallei-Garryetum Borhidi et Muñiz ass. n.
Ekmanio-Erythroxyletum baracoënsis Borhidi ass. n.

14.4. Orden: LANTANO-CORDIETALIA Borhidi ord. n.

Matorrales costeros y cársicos muy secos sobre caliza vinculados a la zona semidesertica, bajo un clima monoxérico, en Cuba mayormente bixérico, formado por arbustos y árboles pequeños deciduos o mayormente esclerófilos, micro-nanófilos y espinosos. Se distribuyen en todas las Antillas y Bahamas, mayormente en las terrazas subcosteras muy secas.

Espécies caracteristicas: *Lantana* espéc. div., *Cordia* espéc. div., *Jacquinia berterii*, *Croton* espéc. div., *Pseudocarpidium* espéc. div., *Guajacum officinale*, *Bursera glauca*, *Guettarda* espéc. div., *Haitiella* espéc. div., *Coccothrinax* espéc. div., *Eugenia* espéc. div., *Spirotecoma spiralis*, *Tabebuia* espéc. div., *Melocactus* espéc. div., *Maytenus buxifolia* ssp. *cochlearifolia*, *Oplonia* espéc. div., *Bellonia* espéc. div., *Diospyrus grisebachii*, *Catesbaea* espéc. div., *Leucocroton microphyllus*.

14.4.1. Alianza: ***Lantano-Cordion*** Borhidi al. n.

Matorrales costeros moderadamente secos, micrófilos, con pocos elementos espinosos. En Cuba se encuentran mayormente en las costas rocosas de Cuba Central y Occidental.

Espécies caracteristicas: *Cordia sebestena*, *C. galeottiana*, *C. globosa* ssp. *humilis*, *Lantana involucrata*, *Savia bahamensis*, *Oplonia tetrasticha*, *Linociera bumelioides*, *Caesalpinia pauciflora*, *Malpighia pallens*, *Tabebuia myrtifolia*, *T. capotei*, *Vitex* espéc. div.

Asociasiones estudiadas:

Linociero-Savietum bahamensis Borhidi y Del Risco ass. n.
Tabebuio-Viticetum guanahacabibensis Borhidi et Capote ass. n.

14.4.2. Alianza: ***Pseudocarpidio-Guettardion*** Borhidi et Muñiz al. n.

Matorrales muy secos formados por arbustos y arbolitos micro-, nano- y leptófilos y espinosos mayormente sobre terrazas calizas rocosas, con una participación notable de cactáceas. En Cuba se encuentran en las costas de Norte y Sur de Oriente.

Espécies caracteristicas: *Pseudocarpidium avicennioides*, *P. multidens*, *Cordia leucosebestena*, *C. curbeloi*, *C. pulverulenta*, *Guettarda cueroensis*, *G. coxiana*, *G. rigida*, *Thouinia pseudopunctata*, *T. stricta*, *Rondeletia acuminata*, *R. ingrata*, *Myrtus oonophylla*, *Guajacum officinale*, *Tabebuia libanensis*, *T. polymorpha*, *Coccothrinax alexandri*, *C. munizii*, *Callicarpa bucheri*, *Plumeria lanata*.

Asociaciones estudiada en Cuba:

Guettardo-Coccothrinacetum munizii Borhidi et Muñiz ass. n.
Pseudocarpidio-Guetterdetum cueroensis Borhidi ass. n.
Erythroxylo-Coccothrinacetum alexandri Borhidi y Muñiz ass. n.

14.4.3. Alianza: ***Crotono-Lantanion*** Borhidi al. n.

Matorrales muy secos, naturales o antropicamente ± influenciados, formados por arbustos micro-, nano- y leptófilos sobre suelos poco profundos arenosos, con menos cactáceas y elementos espinosos. Se distribuyen en todas las Antillas, en Cuba especialmente en las costas de Matanzas y Sur de Oriente.

Espécies caracteristicas en Cuba: *Croton litoralis*, *C. litoralis* ssp. *rugelianus*, *C. betulinus*, *C. corallicola*, *C. rosmarinoides*, *C. myricifolius*, *C. tenuiramis*, *C. stenophyllus*, *C. excisus*, *C. punctatus*, *Lantana parvifolia*, *L. involucrata*, *L. arida*, *Cordia globosa* ssp. *humilis*, *C. leptoclada*, *C. corallicola*, *C. brittonii*, *Neea shaferi*, *Heliotropium ternatum*, *Eugenia cowellii*, *Myrtus cabanasensis*, *Thouinia leonis*, *Mollugo cuneifolia*, *Callicarpa bucheri*, etc.

Asociaciones estudiadas en Cuba:

Eugenio-Crotonetum rosmarinioidis Borhidi y Muñiz ass. n.
Cordio-Crotonetum stenophylloidis Borhidi ass. n.
Heliotropio-Pithecellobietum hystricis Borhidi ass. n.

15. Clase: **COCCOLOBETEA UVIFERAE** Del Risco cl. n.

Matorrales o bosques siempreverdes monodominantes de las costas arenosas de las Antillas, Bahamas y Florida. Por su fisionomia, estructura formada por un solo estrato, carácter deciduo, y composición muy pobre en espécies, debe considerarse una clase separada de la *Coccothrinaci-Plumerietea*, al cuál fue clasificado por KNAPP. Espécies caracteristicas del orden.

15.1. COCCOLOBETALIA UVIFERAE Knapp 1964

Carácteres de la clase: Este orden originalmente fue clasificado por KNAPP dentro de la clase *Coccothrinaci-Plumerietea*.

Espécies caracteristicas: *Coccoloba uvifera*, *Leucaena leucocephala*, *Thespesia populnea*, *Erithalis fruticosa*, *Hippomane mancinella*, *Conocarpus erecta*, *Bursera simaruba*, *Chrysobalanus icaco*, *Crossopetalum rhacoma*, *Thrinax radiata*.

15.1.1. Alianza: ***Coccolobion uviferae*** Borhidi y Muñiz al. n.

Carácteres de la clase. Asociaciones estudiadas en Cuba:

Coccolobetum uviferae (Gleason y Cook 1929) Ciferri 1936

Coccolobo-Thrinacetum radiatae Borhidi y Muñiz ass. n.
Burssereto-Thrinacetum radiatae Borhidi y Muñiz ass. n.

Thrinax wendlandiana-Bursera simaruba Ges. Schubert et al. 1979.

15.1.2. Alianza: ***Leucaenion leucocephalae*** Borhidi y Muñiz al. n.

Matorrales o bosques bajos densos costeros de las costas arenosas ligeramente arcillosas o fangosas.

Asociaciones estudiadas:

Leucaenetum leucocephalae (Stoffers 1956) Borhidi y Muñiz

16. Clase: **BYRSONIMO-PINETEA CARIBAEAE** Samek et Borhidi cl. n.

Pinares y encinares de llanuras y alturas bajas en Honduras, Nicaragua, Cuba occidental, Bahamas y Florida, sobre suelos ácidos de arenas blancas, pizarras y latosoles, raramente sobre calizas. Los bosques originales mayormente estan antropicamente destruidos o modificados en sabanas.

Espécies caracteristicas: *Pinus caribaea* s.l., *P. tropicalis*, *P. elliottii*, *Quercus oleoides* s.l., *Qu. minima*, *Qu. myrtifolia*, *Qu. pumila*, *Byrsonima crassifolia* y espéc. div., *Curatella americana*, *Coccothrinax* espéc. div., *Myrica cerifera*, *Miconia ibaguensis*, *M. splendens*, *Conostegia xalapensis*, *Blechnum serrulatum* ssp. *roigii*, *Pteridium caudatum*, *Andropogon* espéc. div., *Aristida* espéc. div., *Rhynchospora* espéc. div., *Trachypogon* espéc. div., *Leptocoryphium lanatum*, *Axonopus* espéc. div.

16.1. Orden: PINETALIA TROPICALIS-CARIBAEAE Samek em. Borhidi ord. n. Pinares de Cuba Occidental e Isla de Pinos.

Espécies caracteristicas: *Pinus caribaea* ssp. *caribaea*, *P. tropicalis*, *Coccothrinax miraguama* ssp. *arenicola*, *Pachyanthus poiretii*, *P. cubensis*, *P. wrightii*, *Rondeletia correifolia*, *Vaccinium cubense* ssp. *ramonii*, *Purdiaea cubensis*, *Tetrazygia delicatula*, *Hypericum styphelioides*, *Hyptis minutifolia*, *Parathesis cubana*, *Tabebuia lepidophylla*, *Sachsia polycephala*, *Andropogon gracilis*, *A. virginicus*, *Aristida refracta*, *A. vilfifolia*, *Arundinella deppeana*, *Mesosetum loliiforme*, etc.

16.1.1. Alianza: ***Acoelorrapho-Pinion tropicalis*** Samek al. n.

Pinares abiertos o cerrados de las pizarras duras y arenas blancas, cuazosas, facilmente sabanizables, distribuidas en la Isla de Pinos, en el Sur de la Prov. Pinar del Rio e Istmo de Guanahacabibes, donde desaparecieron casi por completo en los ultimos años. Se encuentran también en la parte occidental y sur-occidental de la Sierra de los Organos, sobre pizarras cristalizadas, duras.

Espécies caracteristicas: *Pinus tropicalis*, *Acoelorraphe wrightii*, *Colpothrinax wrightii*, *Chaetolepis cubensis*, *Miconia androsaemifolia*, *Cuphea pseudosilene*, *Pachyanthus cubensis*, *Cro-*

ton cerinus, C. craspedotrichus, Byrsonima verbascifolia, B. pinetorum, B. wrightiana, Calyptranthes pinetorum, Melochia savannarum, Befaria cubensis, Pavonia intermixta, Lyonia vaccinioides, Polygala squamifolia, P. wrightii.

Asociaciones estudiadas:

Paepalantho-Pinetum tropicalis Samek 1969
Eragrosti cubensi-Pinetum tropicalis Samek ap. Hadač 1971

16.1.2. Alianza: ***Blechno-Acoelorraphion wrightii*** Hadac 1971

Palmares en lugeras pantanosos o cenagosos, distróficos u oligotróficos sobre turba o mayormente sobre arena blanca humeda o inundada. Comunidades ± ricas en espécies.

Espécies caracteristicas: *Acoelorraphe wrightii, Colpothrinax wrightii, Myrica cerifera, Blechnum serrulatum.*

Asociaciones estudiadas en Cuba:

Blechno-Acoelorraphetum wrightii Hadač 1971
Chrysobalano-Colpothrinacetum wrightii Borhidi y R. Capote ass. n.

16.1.3. Alianza: ***Neomazaeo-Pinion caribaeae*** Borhidi al. n.

Pinares cerrados sobre latosoles y serpentinas de la Sierra de Cajalbana.

Espécies caracteristicas: *Neomazaea phialanthoides, N. tinifolia, Psidium cymosum, Tetrazygia coriacea, Coccothrinax yuraguana, Phania cajalbanica, Agave cajalbanensis, Gesneria ferruginea, Sauvallella immarginata, Mitracarpus glabrescens, Hyperbaena columbica, Tabebuia lepidota, Eugenia rigidifolia, Jacquinia brunnescens, Rondeletia longisepala, Phyllanthus orbicularis, Vernonia valenzuelana, V. cubensis, Heptanthus ranunculoides, Lescaillea equisetiformis, Rheedia fruticosa, Erythroxylum minutifolium, Anemia cajalbanica.*

Asociaciones estudiadas:

Neomazaeo-Pinetum caribaeae (Samek 1969) Borhidi
(Syn.: *Pinetum caribaeae cajalbanensis typicum* Samek)
Guettardo valenzuelanae-Pinetum Borhidi ass. n.
Agavo cajalbanensi-Pinetum caribaeae Samek 1969

16.1.4. Alianza: ***Pachyantho poiretii-Pinion caribaeae*** Borhidi y Capote al. n.

Pinares de las areniscas duras y esquistosas (formación "San Cayetano") en las Alturas pizarras de las Sierras de los Organos y del Rosario, monodominantes o con la codominancia del encino cubano.

Espécies caracteristicas: *Pinus caribaea, Quercus oleoides* ssp. *sagraeana, Pachyanthus poiretii, P. cubensis, Clidemia neglecta, Vaccinium cubense* ssp. *ramonii, Clidemia strigillosa, Odontosoria wrightiana, Miconia ibaguensis, M. prasina, Phania matricarioides, Ossaea parvifolia, Rhus copallina* ssp. *leucantha, Xylopia aromatica.*

Asociaciones estudiadas:

Querco-Pinetum caribaeae Samek Borhidi y Capote ass. n.
Querco-Pinetum tropicalis Samek ass. n.
Pinetum tropicalis Samek 1969
Pinetum caribaeae Samek 1969
Byrsonimo-Pinetum tropicalis-caribaeae Borhidi et Capote ass. n.

16.2. Orden: QUERCETALIA OLEOIDIS Borhidi ord. n.

Encinares esclerófilos siempreverdes de las llanuras y alturas bajas en Honduras y Nicaragua, México, Cuba Occidental y Florida.

16.2.1. Alianza: ***Quercion sagraeanae*** Borhidi y Capote al. n.

Encinares siempreverdes de Cuba Occidental, sobre suelos profundos derivados de areniscas (formación "Cayetano") o en suelos pardo-amarillos arenosos. En su composición floristica se unen espécies de pinares y de los bosques tropicales semideciduos.

Espécies caracteristicas: *Quercus oleoides* ssp. *sagraeana*, *Xylopia armatica*, *Amaioua corymbosa*, *Alibertia edulis*, *Miconia ibaguensis*, *M. splendens*, *Henriettea patrisiana*, *Pithecellobium cubense*, *Tabebuia lepidophylla*, *Didymopanax morototoni*, *Davilla rugosa*, *Clidemia* espéc. div., *Eugenia punicifolia*, *Psidium salutare*, *Conostegia xalapensis*, *Eugenia farameoides*, *Coccocypselum hirsutum*, *Clusia minor*, *Cordia lineata*, etc., *Andropogon* espéc. div., *Ichnanthus mayarensis*, *Scleria cubensis*, *Rhynchospora cephalotoides*.

Asociaciones estudiadas:

Miconio ibaguensi-Quercetum sagraeanae Borhidi y Capote ass. n.
Rhynchosporo-Quercetum sagraeanae Borhidi ass. n.

17. Clase: **CASEARIO-PINETEA CUBENSIS** Borhidi y Muñiz cl. n.

Pinares de Cuba Oriental sobre suelos primarios o latosoles ácidos derivados de serpentina con una composición floristica riquisima de muy alto porcentaje de endémicos.

Espécies endémicas: *Pinus cubensis*, *Coccothrinax orientalis*, *Bactris cubensis*, *Lyonia macrophylla*, *L. glandulosa*, *L. myrinifolia*, *Casearia crassinervis*, *C. moaensis*, *C. ophiticola*, *Clerodendron nipense*, *Gesneria duchartreoides*, *G. pachyclada*, *G. norlindii*, *Clerodendron nipense*, *Galactia rudolphioides*, *Ossaea pauciflora*, *Myrtus ekmanii*, *M. ophiticola*, *Rondeletia canellifolia*, *R. stellata*, *Ouratea striata*, *Anemia coriacea* s.l., *Eupatorium ayapanoides*, *E. lantanifolium*, *E. polystrictum*, *Eugenia pinetorum*, *Baccharis scoparioides*, *B. shaferi*, *Vernonia* espéc, div., *Odontosoria aculeata*, *Bisgoeppertia scandens*, *Vaccinium cubense* ssp. *cubense*, *V. alainii*. *Schmidtottia shaferi*, *Jacaranda arborea*, *Coccoloba shaferi*, *Siphocampylus* espéc. div., etc.

17.1. Orden: PINETALIA CUBENSIS Borhidi y Muñiz ord. n.
Caracteres de la clase.

17.1.1. Alianza: ***Guettardo-Pinion cubensis*** Borhidi al. n.
Pinares xerotérmicos de alturas bajas sobre latosoles y los pinares abiertos saxicolas de serpentinas, con un estrato arbustivo siempreverde desarrollado, formado por los elementos endémicos de los matorrales de las serpentinas de Cuba oriental (charrascales).

Espécies caracteristicas: *Anemia coriacea* s.l., *Casearia* espéc. div., *Euphorbia helenae, Tabebuia simplicifolia, Plumeria clusioides, Clerodendron nipense, Dracaena cubensis, Guettarda crassipes, G. monocarpa, G. ferruginea, Agave shaferi, Ariadne shaferi, Tabebuia pinetorum, Rheedia ophiticola, Eugenia cycloidea, Mouriri emarginata, Linodendron aronifolium*, etc.

Asociaciones estudiadas:

Anemio coriaceae-Pinetum cubensis (Samek 1974) Borhidi
Euphorbio helenae-Pinetum cubensis (Samek 1974) Borhidi
Agavo shaferi-Pinetum cubensis (Samek 1974) Borhidi
Dracaeno-Pinetum cubensis Borhidi ass. n.

17.1.2. Alianza: ***Andropogoni-Pinion cubensis*** Borhidi al. n.
Pinares mesofilos y montanos de Cuba Oriental sobre latosoles de serpentinas, con arboles siempreverdes entremezclados y un estrato erbáceo desarollado.

Espécies caracteristicas: *Pinus cubensis, Tabebuia dubia, Scolosanthus lucidus, Spirotecoma apiculata, Hieronyma nipensis, Clethra cubensis, Guatteria cubensis, Mettenia* espéc. div., *Miconia cerasiflora, M. obovata, Ossaea rufescens, O. munizii, O. pinetorum, O. pseudopinetorum, Cordia pedunculosa, C. utermarkiana, C. moaensis, C. toaensis, Alsophila aqulina, Nephelea pubescens, Eupatorium grandiceps, Psychotria moaensis, Lyonia obovata, L. macrophylla, L. longipes, Cestrum buxoides, Calycogonium grisebachii, Cyrilla nipensis, Myrica shaferi, Ilex macfadyenii*, etc.

Asociaciones estudiadas:

Rhynchosporo-Pinetum cubensis (Samek 1974) Borhidi
Shafero-Pinetum cubensis Borhidi y Muñiz ass. n.

18. Clase: **PHYLLANTHO-NEOBRACETEA VALENZUELANAE** Borhidi y Muñiz cl. n.

Matorrales siempreverdes, mayormente espinosos de serpentinas en las llanuras y alturas bajas a medianas de Cuba, formados por arbustos y arbolitos esclerófilos micro-, nano- y leptófilos con muchos elementos espinosos y alto porcentaje de espécies endémicas.

Espécies caracteristicas: *Phyllanthus orbicularis* y espéc. div., *Neobracea valenzuelana, Moacroton* espéc. div., *Leucocroton* espéc. div., *Harpalyce* espéc. div., *Buxus* espéc. div., *Coccoloba* espéc. div., *Euphorbia* (sect. *Euphorbiodendron*), *Erythroxylon minutifolium, Annona bullata, Myrtus anomala, Tabebuia lepidota, Notodon* espéc. div., *Piscidia cubensis, Malpighia nummulariifolia, M. cnide, Rondeletia camarioca, R. savannarum, Cynanchum ophiticola, C. orientensis, Passiflora cubensis, Zanthoxylum dumosum, Bourreria divaricata, B. microphylla*, etc.

18.1. Orden: ARIADNO-PHYLLANTHETALIA Borhidi y Muñiz ord. n.

Matorrales espinosos de las llanuras, zonas colinosas y alturas medianas de las montañas de serpentinas en Cuba Oriental, formados por espécies y géneros endémicos sobre suelos pedregosos esqueléticos (rendzinas de serpentina) o latosoles muy maduros con estratos de mocarrero. El orden es muy rico en comunidades, y estudios futuros van a servir para la distinción de alianzas varias.

Espécies caracteristicas: *Ariadne shaferi* s.l., *Phyllanthus myrtilloides* s.l., *Ph. chamaecristoides* s.l., *Ph. comosus, Ph. chryseus, Ateramnus recurvus, Rheedia ophiticola, R. polyneura, R. revoluta, R. ruscifolia, Moacroton revolutus, Adenoa (Piriqueta) cubensis, Pseudocarpidium pungens, Crossopetalum ternifolium* s.l., *Galactia revoluta, Annona sclerophylla, Calycogonium rosmarinifolium* s.l., *C. moanum, Schmidtottia* espéc. div., *Euphorbia podocarpifolia, E. helenae, Coccoloba nipensis, C. acunae, C. praestans, Byrsonima minutifolia, B. biflora, Machaonia nipensis, Antirhea abbreviata* s.l., *Xylosma buxifolium, Guettarda ferruginea, G. shaferi, Oplonia cubensis, Erythroxylum pedicellare, E. longipes, E. coriaceum, Spathelia pinetorum, S. splendens*, etc

18.1.1. Alianza: ***Ariadno-Phyllanthion*** Borhidi y Muñiz al. n.

Caracteres del orden. Asociaciones estudiadas:

Spathelio-Bourrerietum pauciflorae Borhidi ass. n.
Byrsonimo-Myrtetum acunae Borhidi ass. n.
Antirheo-Acrosynanthetum minoris Borhidi y Muñiz ass. n.
Jacquinio-Tabebuietum linearis Borhidi y Muñiz ass. n.
Myrto ophiticolae-Mouririetum emarginatae Borhidi ass. n.
Myrto ekmanianae-Moacrotonetum leonis Borhidi ass. n.
Spathelio splendenti-Gochnatietum recurvae Borhidi ass. n.

18.2. Orden: PHYLLANTHO-NEOBRACETALIA VALENZUELANAE Borhidi y Muñiz ord. n.

Matorrales siempreverdes esclerófilos, mayormente espinosos de las llanuras y alturas bajas de Cuba Central y Occidental (hasta la zona sepentinosa de Holguin).

Espécies caracteristicas: *Phyllanthus orbicularis, Neobracea valenzuelana, Tabebuia lepidota, T. trachycarpa, Rondeletia camarioca, R. venosa, R. savannarum, Eugenia camarioca, Scolosanthus crucifer* s.l., *Pseudocarpidium ilicifolium, Zanthoxylum dumosum, Oplonia nannophylla, Coccoloba armata, C. pallida, C. microphylla, Guettarda calyptrata, G. echinodendron, Galactia galactioides, Erythroxylon minutifolium, Copernicia macroglossa, C. hospita, Bursera angustata, Bonania emarginata, Bourreria divaricata, B. setoso-hispida, B. microphylla*, etc.

18.2.1. Alianza: ***Neomazaeo-Reynosion retusae*** Borhidi y Capete al. n.
Matorrales siempreverdes esclerófilos espinosos en las serpentinas de la Sierra de Cajalbana y Sierra del Rosario con un numero considerable de endémicos.

Espécies caracteristicas: *Neomazaea phialanthoides, Reynosia retusa, Zanthoxylum cajalbanicum, Z. acunae, Buxus wrightii, Scolosanthus acunae, Rheedia fruticosa, Leucocroton revolutus, Moacroton trigonocarpus, Machaonia dumosa, Bourreria badia, Coccoloba coriacea, Lescaillea equisetiformis, Agave cajalbanensis, Ayenia cajalbanensis, Helicteres trapezifolia, Pisonia petiolaris, Rondeletia longibracteata, R. venosa, Phyllanthus discolor, Eugenia rigidifolia*, etc.

Asociaciones estudiadas:

Erythroxylo-Coccolobetum armatae Borhidi y Capote ass. n.
Eugenio-Moacrotonetum trigonocarpi Borhidi y Capote ass. n.
Zanthoxylo-Reynosietum retusae Borhidi ass. n.
Neomazaeo-Phyllanthetum orbicularis Borhidi et Capote ass. n.

18.2.2. Alianza: ***Coccothriancio-Tabebuion lepidotae*** Borhidi y Muñiz al. n.
Matorrales y bosques arbustosos bajos espinosos de serpentina de Cuba Occidental (provincias Habana y Matanzas).

Espécies caracteristicas: *Bucida ophiticola, Leucocroton havanensis, L. moncadae, Lasiocroton bahamensis, Eugenia sauvallei, Psidium havanense, Harpalyce cubensis, H. suberosa, Buxus flaviramea, Reynosia intermedia, Gossypianthus heterophyllus, Melocactus matanzanus, Moacroton revolutus, Acacia daemon*, etc.

Asociaciones estudiadas:

Pseudocarpidio-Bucidetum ophiticolae Borhidi ass. n.
Eugenio-Coccothrinacetum roseocarpae Borhidi ass. n.
Coccothrinaci roseocarpae-Bucidetum ophiticolae Berazain ass. n.

18.2.3. Alianza: ***Guettardo-Jacarandion cowellii*** Borhidi y Muñiz al. n.
Matorrales esclerófilos siempreverdes espinosos sobre serpentinas de las llanuras y alturas bajas de Cuba Centro-Oriental (Serpentinas de Motembo, Santa Clara, Camagüey y Holguin), formados por árboles y arbustos micro-, nano- y leptófilos con muchos endémicos vicariantes locales.

Espécies caracteristicas: *Guettarda clarensis, G. roigiana, G. camagüeyensis, G. shaferi, Zanthoxylum nannophyllum, Coccoloba geniculata, Jacaranda cowellii, Pictetia marginata, P. spinifolia, Behaimia cubensis, Notodon savannarum, Henoonia myrtifolia, Croton heteropleurus, C. camagüeyanus, C. holguinensis, C. nephrophyllus, C. acunae, Eugenia* espéc. div., *Copernicia cowellii, C. pseudorigida, C. hospita, Coccothrinax clarensis, C. camagüeyana, C. garciana, Tabebuia trachycarpa, Platygyne parvifolia, Machaonia subinermis, M. urbinoi, M. minutifolia, Jacquinia shaferi, Karwinskia oblongata, K. orbiculata, Daphnopsis longifolia*, etc.

Asociaciones estudiadas:

Rondeletio-Guettardetum clarensis Borhidi y Muñiz ass. n.
Copernicio cowellii-Tabebuietum trachycarpae Borhidi y Muñiz ass. n.
Erythroxylo-Crotonetum holguinensis Borhidi ass. n.
Acacio belairioidi-Spirotecometum holguinensis Borhidi ass. n.

19. Clase: **SABALO-ROYSTONIETEA** Borhidi y Muñiz en Borhidi y Herrera 1977

Sabanas* de hierbas y palmas altas formadas por lo común secundariamente sobre suelos aluviales o latosolicos mayormente profundos bajo una influencia antrópica (quema y pastóreo) regularmente repetida.

19.1. Orden: PASPALO-ROYSTONIETALIA Borhidi y Muñiz ord. n.
Sabanas con palma réal distribuidas en las llanuras y zonas colinosas de Cuba Central sobre suelos latosolicos fértiles.

19.1.1. Alianza: ***Ceibo-Roystonion*** Borhidi y Muñiz en Borhidi y Herrera 1977.
Sabanas* con palma real en suelos latosolicos profundos de las llanuras fértiles distribuidas en las areas originalmente ocupadas por bosques humedos tropicales, condicionados por un clima estacionalmente seco en invierno con 1—2 meses secos.

Espécies caracteristicas: *Roystonea regia*, *Ceiba pentandra*, *Spondias mombin*, *Andira inermis*, *Guazuma ulmifolia*, *Chrysophyllum oliviforme*, *Andropogon virginicus*, *A. caricosus*, *A. pertusus*, *Papalum notatum*, *P. distichum*, *P. divaricatum*, *P. fimbriatum*, *Panicum geminatum*, *P. caespitosum*, *P. pilosum*, *P. boliviensis*, *P. adspersum*, *Cyperus haspan*, *C. surinamensis*, *Setaria tenax*, *Sporobolus indicus*, *Imperata contracta*, *Reynaudia filiformis*, *Rhynchelytrum repens*, etc.

Asociaciones estudiadas:

Paspalo-Roystonietum regiae Borhidi ass. n.
Andropogoni caricosi-Roystonietum regiae Borhidi ass. n.

19.1.2. Alianza: ***Samaneo-Roystonion*** Borhidi y Muñiz en Borhidi y Herrera 1977.
Sabanas con palma real sobre suelos medianamente fértiles, suelos latosólicos poco profundos de las llanuras. Se encuentran en áreas de un clima estacionalmente seco con 3—6 meses secos, ocupadas originalmente por bosques semideciduos.

* Para distinguir las sabanas neotropicales de las africanas correspondientes E. Del-Risco propone utilizar el termino: "Pseudosabana"

Espécies caracteristicas: *Roystonea regia, Samanea saman, Peltophorum adnatum, Pithecellobium cubense, Psidium guayava, Anacardium edule, Bursera simaruba, Cordia gerascanthus, Paspalum plicatum, Andropogon saccharioides, Panicum ghisbreghtii, Setaria geniculata, Sorghastrum aetosum, Cassia aeschynomene, Stylosanthes hamata, Alysicarpus vaginatus, Pectis floribunda, Borreria verticillata* y las gramineas y ciperáceas mencionadas en la alianza anterior.

Asociaciones estudiadas:

Paspalo plicatuli-Sporoboletum indici Ciferri 1936.

19.2. Orden: MAGNOCOPERNICIO-SABALETALIA Borhidi ord. n.

Sabanas semiantrópicas mas o menos edáficamente condicionadas, estacionalmente inundadas en los valles de los rios, en suelos aluviales gleyizados o en suelos mocarreros.

19.2.1. Alianza: ***Copernicion giganti-rigidae*** Borhidi en Borhidi y Herrera 1977.

Sabanas estacionalmente inundadas sobre suelos gleyizados o sobre mocarreros, por parte naturales, edáficamente condicionadas por la fluctuación extrema del nivel freático; por parte secundarias derivadas por la tala de los bosques aluviales de los rios en las llanuras de Cuba Centro-Oriental (Las Villas, Camagüey y Oriente).

Espécies caracteristicas: *Copernicia gigas, C. baileyana, C. sueroana, C. rigida, C. hospita, C. vespertilionum, C. textilis, Belairia mucronata, Acacia* espéc. div., *Caesalpinia* espéc. div., *Pithecellobium* espéc. div., *Andropogon* espéc. div., *Scleria* espéc. div., *Rhynchospora* espéc. div., *Fimbristylis* espéc. div., etc.

Asociaciones estudiadas:

Belairio-Copernicietum rigidae Borhidi ass. n.

19.2.2. Alianza: ***Andropogoni-Sabalion*** Borhidi en Borhidi y Herrera 1977.

Sabanas naturales edáficas o semiantrópicas en suelos mocarrero estacionalmente inundados, condicionados por la fluctuación del nivel freático y por la quema. Se distribuyen mayormente en las llanuras de Cuba Occidental y Centro-Occidental (Provincias de Pinar del Rio, Habana y Matanzas, Isla de Pinos).

Espécies caracteristicas: *Sabal parviflora, Bucida subinermis, Belairia savannarum, Cameraria retusa, Croton sagraeanus, Caesalpinia savannarum, Acacia* espéc. div., *Cheilophyllum* espéc. div., *Andropogon virginicus, A. saccharoides, A. gracilis, Paspalum distortum, Panicum stenodes, Eragrostis cubensis, Eriochloa setosa, Chloris cubensis, Setaria geniculata, Scleria* espéc. div., *Rhynchospora* espéc. div., etc.

Asociaciones estudiadas:

Andropogoni-Sabaletum parviflorae Borhidi y Del Risco ass. n.

20. Clase: **CURATELLO-BYRSONIMETEA** Borhidi cl. n.

Sabanas neotropicales secas de hierbas bajas sobre suelos de baja fertilidad arenosos o arcillosos provistos de un estrato de arrecife o mocarrero. Las comunidades son caracterizados por grupos o individuos dispersos de arbustos siempreverdes esclerófilos, arbolitos micro- a leptófilos, pinos o palmas bajas.

Espécies caracteristicas: *Byrsonima crassifolia*, *B. verbascifolia*, *Curatella americana*, *Bulbostylis paradoxa*, etc.

20.1. Orden: PARVICOPERNICIO-COCCOTHRINACETALIA Borhidi y Muñiz en Borhidi y Herrera 1977.

Sabanas serpentinosas y arenosas semiantrópicas formadas por tala quema y pastóreo de los pinares y matorrales originales de mismos suelos.

Espécies caracteristicas: *Andropogon multinervosus*, *A. hirtiflorus*, *A. virgatus*, *A. gracilis*, *Aristida* espéc. div., *Leptocoryphium lanatum*, *Eriochloa setosa*, *Eragrostis cubensis*, *Rhynchospora diodon*, *R. tenuis*, *Panicum aciculare*, *P. chrysopsidifolium*, *Ichnanthus mayarensis*, etc.

20.1.1. Alianza: ***Parvicopernicio-Coccothrinacion*** Borhidi y Muñiz en Borhidi y Herrera 1977.

Sabanas serpentinosas de Cuba.

Espécies caracteristicas: *Copernicia macroglossa*, *C. pauciflora*, *C. cowellii*, *C. yarey*, *Coccothrinax miraguama* subespéc. div., *C. pseudorigida*, *C. clarensis*, *C. camagüeyana*, *C. garciana*, *Rondeletia* espéc. div., *Tabebuia lepidota*, *Bourreria* espéc. div., *Mitracarpus squarrosus*, *Tripogon spicatus*, *Ayenia euphrasifolia*, *Croton nummulariifolius*, *Polygala saginoides*, *Evolvulus* espéc. div., *Passiflora cubensis*, *Aristolochia passiflorifolia*, etc.

Asociaciones estudiadas:

Andropogoni spiciformi-Copernicietum rigidae Borhidi ass. n.
Polygalo saginoidi-Copernicietum cowellii Borhidi y Muñiz ass. n.
Aristido neglectae-Copernicietum macroglossae Borhidi ass. n.
Aristido vilfifoliae-Coccothrinacetum garcianae Borhidi ass. n.

20.1.2. Alianza: ***Acoelorrapheto-Colpothrinacion*** Borhidi y Capote al. n.

Sabanas secas o medianamente humedas de las arenas blancas con palmas y pinos, en Cuba Sur-Occidental e Isla de Pinos, mayormente como productos de la degradación de los pinares arenosos.

Espécies caracteristicas: *Acoelorraphe wrightii*, *Colpothrinax wrightii*, *Pinus tropicalis*, *Melochia savannarum*, *Hyptis pedalipes*, *Aster grisebachii*, *Aristida* espéc. div., *Mesosetum loliiforme*, *Turnera acaulis*, *Croton cerinus*, *C. craspedotrichus*, y sinusios de eriocauláceas y xyridáceas.

Asociaciones estudiadas:

Pino-Aristidetum neglectae Borhidi ass. n.

21. Clase: **CERCIDI-PROSOPIDETEA** Knapp 1964.

Espinares o bosques arbustoros espinosos densos, deciduos, formados mayormente por Mimosáceas, Caesalpiniáceas espinosas en América Central y Antillas.

21.1. Orden: ACACIO-CAPPARIDETALIA Knapp 1964.

Espinares o bosques arbustosos espinosos densos de las zonas hiperxerofíticas costeras y subcosteras de las Antillas y Bahamas, mayormente sobre caliza bajo un clima bixérico de 7—9 meses secos y 600—800 mm de lluvia anual.

21.1.1. Alianza: ***Acacio-Caesalpinion coriariae*** Borhidi al. n.

Carácteres del orden.

Espécies caracteristicas en Cuba: *Acacia farnesiana*, *A. curbeloi*, *A. cupeyensis*, *A. roigii*, *A. macracanthoides*, *A. lutea*, *A. cowellii*, *Pithecellobium mucronatum*, *P. circinale*, *P. hystrix*, *P. oppositifolium*, *Prosopis juliflora*, *Phyllostylon brasiliense*, *Cassia stenophylla*, *Haematoxylon campechianum*, *Caesalpinia bahamensis* s.l., *C. pauciflora*, *C. subglauca*, *C. coriaria*, *C. pinnata*, *Capparis* espéc. div., *Agave underwoodii*, *A. legrelliana*, *Scolosanthus bahamensis*, etc.

Asociaciones estudiadas:

Phyllostylo-Acacietum luteae Ciferri 1936.

22. Clase: **CERCIDIO-CEREETEA** Knapp 1964.

Vegetación desertica o semidesertica abierta, con la dominancia de cactáceas arbóreas y columnares, en América de Norte, Central y en las Antillas.

22.1. Orden: LEMAIROCEREETALIA HYSTRICIS Knapp 1964.

Vegetación semidesertica costera y subcostera, rica en suculentas de las Antillas Mayores y Sur de Bahamas, bajo un clima árido de 9—11 meses secos y 300—600 mm de lluvia anual.

Espécies caracteristicas: *Lemairocereus hystrix*, *Pilosocereus* espéc. div., *Consolea* espéc. div., *Melocactus* espéc. div., *Cylindropuntia hystrix*, *Opuntia dillenii* s.l., *Capparis* espéc. div., *Guajacum officinale*, *Croton* espéc. div., *Agave* espéc. div., etc.

22.1.1. Alianza: ***Consoleo-Lemairocereion hystricis*** Borhidi y Muñiz al. n.

Vegetación semidesertica con abundancia de cactáceas arbóreas y columnares, representadas mayormente por espécies endémicas vicariantes an cada isla de las Antillas Mayores y en las islas surenas de las Bahamas.

Espécies caracteristicas en Cuba: *Consolea macracantha, C. millspaughii, Lemairocereus hystrix, Pilosocereus brooksianus, P. robinii, Cylindropuntia hystrix, Melocactus harlowii, M. borhidii, M. acunai, Rhodocactus cubensis, Opuntia militaris, Harrisia fernowii, Agave albescens, Caesalpinia pinnata, C. pauciflora, Capparis grisebachii, C. flexuosa, Gochnatia microcephala, G. elliptica*, etc.

Asociaciones estudiadas:

Consoleo-Colubrinetum ellipticae Borhidi y Muñiz ass. n.
Lemairocereo-Lasiocrotonetum bahamensis Borhidi y Muñiz ass. n.
Lemairocereo-Phyllostyletum brasiliensis Borhidi y Muñiz ass. n.
Cappari-Lemairocereetum hystricis Borhidi y Muñiz ass. n.
Lemairocereo-Guettardetum cueroensis Borhidi ass. n.

23. Clase: **OCOTEO-MAGNOLIETEA** Borhidi y Muñiz cl. n.

Pluvisilvas montanas de la región del Caribe, especialmente en las cordilleras orientales de México y en las montañas de las Antillas, caracterizadas por helechos arbóreos, por abundancia de epífitos, musgos y hepáticas epífilas.

Espécies caracteristicas: *Ocotea* espéc. div., *Magnolia* espéc. div., *Laplacea* espéc. div., *Cyrilla* espéc. div., *Brunellia comocladifolia, Freziera* espéc. div., *Podocarpus* espéc. div., *Talauma* espéc. div., *Cyathea* espéc. div., *Lophosoria quadripinnata, Clethra* espéc. div., *Prestoea montana, Calyptronoma* espéc. div., etc.

23.1. Orden: OCOTEO-MAGNOLIETALIA Borhidi y Muñiz ord. n.
Pluvisilvas latifolias montanas humedas sobre suelos amarillos derivados de rocas diversas no serpentinosas — en Cuba en las Sierras de Escambray, Maestra y de Imias entre 800 y 1600 m. de altura.

Espécies caracteristicas: *Magnolia cubensis* s.l., *M. cacuminicola, O. cuneata, O. leucoxylon, O. acunaiana, O. ekmanii, Persea* espéc. div., *Beilschmiedia pendula, Guatteria blainii, Laplacea angustifolia, L. urbanii, Matayba domingensis, Prestoea montana, Talauma minor, Ossaea ottoschmidtii, O. turquinii, Gesneria viridiflora* s.l., *Mecranium amygdalinum, Hedyosmum grisebachii*, etc.

23.1.1. Alianza: ***Magnolion cubensis*** Borhidi y Muñiz al. n.
Caracteres del orden. Asociaciones estudiadas:

Magnolio-Laplaceetum angustifoliae Borhidi y Muñiz ass. n.
Ocoteo ekmanii-Cyrilletum antillanae Borhidi ass. n.
Magnolio acunae-Cyrilletum antillanae Borhidi y Muñiz ass. n.

23.2. Orden: PINETALIA OCCIDENTALIS-MAESTRENSIS Knapp 1964. em. Borhidi.
Pinares en la zona de las pluvisilvas montanas en las Antillas Mayores.

Espécies caracteristicas: *Pinus occidentalis*, *P. maestrensis*, *Gleichenia bifida*, *G. flexuosa*, *G. palmata*, *G. pectinata*, *Cyathea* espéc. div., *Alsophila* espéc. div., *Clethra* espéc. div.

23.2.1. Alianza: ***Pinion maestrensis*** Borhidi al. n.

Pinares montanas en las areniscas y andesitas de la Sierra Maestra.

Espécies caracteristicas: *Myrsine coriacea*, *Clethra cubensis*, *Viburnum villosum*, *Vaccinium leonis*, *Lyonia* espéc. div., *Ilex* espéc. div., *Solonia reflexa*, *Vernonia praestans*, *V. parvuliceps*, *Myrica punctata*, *Miconia acunae*, *M. remotiflora*, etc.

Asociaciones estudiadas:

Clethro-Pinetum maestrensis Borhidi ass. n.

23.3. Orden: PODOCARPO-SLOANETALIA Borhidi y Muñiz ord. n.

Pluvisilvas montanas micro-, notófilas, semisecas, pobres en epifitos, musgos y hepáticas epifilas. Crecen sobre latosoles de serpentina ácidos, pobres en nutrientes, en las Sierras de Nipe y Cristal, Cuchillas de Moa, Toa y Baracoa (Cuba Oriental).

23.3.1. Alianza: ***Podocarpo-Byrsonimion orientensis*** Borhidi y Muñiz al. n.

Espécies caracteristicas: *Podocarpus aristulatus*, *P. ekmanii*, *Sloanea curatellifolia*, *Hieronyma nipensis*, *Talauma oblongata*, *Guatteria moralesii*, *Byrsonima orientensis*, *Calophyllum utile*, *Terminalia nipensis*, *T. pachystyla*, *T. orientensis*, *Mozartia gundlachii*, *Ocotea* espéc. div., *Coccoloba costata*, *Leucocroton wrightii*, *L. longibracteatus*, etc.

Asociaciones estudiadas:

Dipholi cubensi-Calophylletum utilis Borhidi ass. n.
Podocarpo-Bonnetietum cubensis Borhidi y Muñiz ass. n.
Hieronymo-Sloanetum curatellifoliae Borhidi ass. n.

23.3.2. Alianza: ***Cyrillo-Pinion cubensis*** Borhidi y Muñiz al. n.

Bosques ribereñas montanas en la zona de los pinares de latosoles sobre serpentinas de Oriente.

Espécies caracteristicas: *Cyrilla nipensis*, *Calyptronoma orientensis*, *Bactris cubensis*, *Senecio polyphlebius*, *S. rivalis*, *Hedyosmum crassifolium*, *Pachyanthus reticulatus*, *Calyptranthes punctata*, *C. calyptrata*, *C. cardiophylla*, *C. monocarpa*, *Isachne leersioides*, *Cladium restioides*, *Paepalanthus rivularis*, etc.

Asociaciones estudiadas:

Cyrillo nipensi-Pinetum cubensis Borhidi y Muñiz ass. n.

23.4. Orden: CALYPTRONOMO-CYRILLETALIA Borhidi ord. n.

Bosques ribereños no serpentinosos con abundancia de palmas, en las montañas y alturas bajas de Cuba.

Espécies caracteristicas: *Calyptronoma* espéc. div., *Cyrilla* espéc. div., *Dendropanax* espéc. div., *Didymopanax morototoni*, *Isertia haenkeana*, *Senecio* espéc. div., *Calophyllum* espéc. div., *Calyptranthes* espéc. div., *Myrcia* espéc. div., *Hirtella americana*, *Alsophila* espéc. div., *Cyathea minor*, *Pilea* espéc. div., etc.

23.4.1. Alianza: ***Calyptronomo-Cyrillion racemiflorae*** Borhidi al. n.
Bosques ribereñas en Cuba Occidental y Central.

Espécies caracteristicas: *Calyptronoma dulcis*, *C. intermedia*, *C. microcarpa*, *Cyrilla racemiflora*, *Calophyllum antillanum*, *C. antillanum* ssp. *pinetorum*, *Dendropanax cuneifolius*, *Calyptranthes ferruginea*, *C. clementis*, *Pachyanthus angustifolius*, *Alsophila myosuroides*, *Henriettea patrisiana*, etc.

Asociaciones estudiadas:

Calyptronomo-Cyrilletum racemiflorae Borhidi y Capote ass. n.

23.4.2. Alianza: ***Calyptronomo-Cyrillion antillanae*** Borhidi al. n.
Bosques ribereños en Cuba Oriental, especialmente en la Sierra Maestra, donde se llama "manacales".

Espécies caracteristicas: *Calyptronoma clementis*, *Bactris cubensis*, *Cyrilla antillana*, *Mozartia manacalensis*, *M. maestrensis*, *Rondeletia calophylla*, *Calophyllum rivulare*, *Chimarrhis cubensis*, *Phaius tankervilliae*, *Eugenia laeteviridis*, *E. maestrensis*, etc.

Asociaciones estudiadas:

Calyptronomo-Cyrilletum antillanae Borhidi ass. n.

24. Clase: **RONDELETIO-GESNERIETEA** Borhidi cl. n.

Matorrales ribereños sobre la rocalla humeda, deposita a lo largo de los arroyos del piso montano en las sierras de las Antillas.

Espécies caracteristicas: *Rondeletia* espéc. div., *Gesneria humilis* y espéc. div., *Exostema longiflorum* y espéc. div., *Buxus* espéc. div., *Eugenia* espéc. div., *Calyptranthes* espéc. div., *Plinia* espéc. div., *Aster* espéc. div., *Ginoria americana* y espéc. div., *Pilea* espéc. div., *Heptanthus* espéc. div., *Sapphoa rigidifolia*, *Phyllanthus* espéc. div., *Erigeron bellioides* y espéc. div., *Chaptalia* espéc. div., etc.

24.1. Orden: RONDELETIO-GINORIETALIA Borhidi ord. n.
Matorrales ribereños sobre rocas distintas, no serpentinosas.

24.1.1. Alianza: ***Rondeletio microphyllae-Ginorion*** Borhidi y Capote al. n.
Matorrales ribereños en las Sierras de Cuba Occidental y Central.

Espécies caracteristicas: *Rondeletia microphylla*, *R. peduncularis*, *Ginoria americana*, *G. ginorioides*, *Exostema longiflorum*, *Jussiaea decurrens*, *Aster burgessii*, *Cuphea lobelioides*, *Eugenia oligantha*, *Erigeron thrincioides*, *E. paucilobus*, *E. capillipes*, *Oldenlandia capillipes*, etc.

Asociaciones estudiadas:

Rondeletio microphyllae-Gesnerietum humilis Borhidi ass. n.
Eugenio-Cupheetum lobelioidis Borhidi ass. n.
Exostemo-Ginorietum americanea Borhidi et Capote ass. n.

24.2. Orden: RONDELETIO-PURDIAEETALIA Borhidi ord. n.
Matorrales ribereños en las sierras serpentinosas de Cuba Oriental.

Espécies caracteristicas: *Rondeletia pachyphylla*, *R. alaternoides*, *Purdiaea* espéc. div., *Leucocroton* espéc. div., *Heptanthus* espéc. div., *Pilea* espéc. div., *Mozartia* espéc. div., *Calyptranthes* espéc. div., *Gundlachia* espéc. div., *Schmidtottia* espéc. div., *Chaptalia* espéc. div., etc.

24.2.1. Alianza: ***Purdiaeo-Rondeletion pachyphyllae*** Borhidi al. n.
Matorrales riberenos en las rocallas de serpentinas en las sierras del Norte de Oriente, representados por muchas asociaciones de composición distinta, formadas mayormente por espécies endémicas vicariantes.

Espécies caracteristicas: *Rondeletia pachyphylla*, *R. shaferi*, *R. alaternoides*, *R. vacciniifolia*, *Calyptranthes monocarpa*, *C. moaensis*, *C. toaensis*, *C. pseudomoaensis*, *Leucocroton stenophyllus*, *L. obovatus*, *Purdiaea shaferi*, *P. ekmanii*, *P. moaensis*, *P. velutina*, *Acrosynanthus revolutus*, *Oldenlandia polyphylla*, *Schmidtottia cubensis*, *S. monantha*, *S. uliginosa*, *Buxus foliosa*, *Exostema stenophyllum*, *Heptanthus cordifolius*, *H. shaferi*, *Chaptalia nipensis*, *C. shaferi*, etc.

Asociaciones estudiadas:

Exostemo-Leucocrotonetum stenophylli Borhidi ass. n.
Buxo foliosae-Acrosynanthetum revoluti Borhidi y Muñiz ass. n.

24.2.2. Alianza: ***Gundlachio-Bryon subinermis*** Borhidi al. n.
Matorrales ribereños sobre varadas arenoso-gravillosas en los arroyos de las montañas de Oriente.

Espécies caracteristicas: *Gundlachia lindeniana*, *G. cubana*, *G. apiculata*, *Brya subinermis*, *B. chrysogonii*, *Tabebuia rivularis*, *Ginoria montana*, *G. arborea*, etc.

Asociaciones estudiadas:

Gundlachio-Bryetum subinermis Borhidi y Muñiz ass. n.

25. Clase: **WEINMANNIO-CYRILLETEA** Knapp 1964.

Montes nublados y musgosos de las montañas altas en las Antillas, ricos en micro-orquïdeas epifiticas en helechos arbóreos y epifiticos (e. g. espécies de los géneros *Polypodium*, *Microlepis*, *Grammitis*, *Hymenophyllum*,

Feea, *Trichomanes*, *Elaphoglossum* etc.), en licopodiáceas, en musgos y hepáticas terrestres, ramicolas y epifiticos.

Espécies caracteristicas en Cuba: *Weinmannia pinnata*, *Cyrilla antillana*, *Persea similis*, *P. anomala*, *Ocotea ekmanii*, *Cyathea arborea*, *C. balanocarpa*, *C. insignis*, *Nephelea pubescens*, *Dennstaedtia* espéc. div., *Marattia alata*, *Gleichenia* espéc. div., *Torralbasia domingensis*, *Ternstroemia* espéc. div. Melastomatáceas, Ericáceas, etc.

25.1. Orden: WEINMANNIO-CYRILLETALIA Knapp 1964
Carácteres de la clase.

25.1.1. Alianza: ***Cyrillo-Myrsinion*** Borhidi y Muñiz al. n.
Montes nublados de las Antillas Mayores, en Cuba se encuentran en Sierra Maestra entre 1600 y 1900 m de altura.

Espécies caracteristicas: *Myrsine microphylla*, *Nectandra reticularis*, *Sapium maestrense*, *Ditta maestrensis*, *Torralbasia domingensis*, *Garrya fadyenii*, *Hedyosmum cubense*, *H. domingense*, *Henriettea ekmanii*, *Tetrazygia elegans*, *Ternstroemia leonis*, *T. monticola*, *Miconia turquinensis*, *Ossaea maestrensis*, *Scolosanthus maestrensis*, *Lepanthes* espéc. div., *Pleurothallis* espéc. div., *Stelis ophioglossoides*, y musgos: *Phyllogonium fulgens*, *Meteriopsis patula*, *Mettenothamnium reptans*, *Macromitrium* espéc. div., *Hypnum polypterum*, *Pilotrichella flexilis*, *Rhizogonium spiniforme*, etc.

Asociaciones estudiadas:

Myrsino-Nectandretum reticularis Borhidi y Muñiz ass. n.

26. Clase: **MYRICO-BACCHARIDETEA** Knapp 1964.

Matorrales micrófilos siempreverdes humedos subalpinos entre las zonas de los montes nublados y páramos.

Espécies caracteristicas: *Myrica* espéc. div., *Baccharis* espéc. div., *Lyonia* espéc. div., *Vaccinium* espéc. div., *Ilex* espéc. div., etc.

26.1. Orden: MYRICO-LYONIETALIA Knapp 1964. em. Borhidi
Matorrales micrófilos subalpinos de las Antillas Mayores.

26.1.1. Alianza: ***Ilici-Myricion*** Borhidi y Muñiz al. n.
Matorrales subalpinos en las rocas y paredones de la zona de montes nublados (en Cuba solo en el grupo del Pico Turquino, cima supremo de la Sierra Maestra).

Espécies caracteristicas: *Ilex turquinensis*, *I. nunezii*, *I. nannophylla*, *Lyonia calycosa*, *L. turquini*, *Peratanthe cubensis*, *Myrica cacuminis*, *Lobelia cacuminis*, *Micromeria bucheri*, *Salvia speirematoides*, *Rubus turquinensis*, *Vernonia praestans* var. *cacuminis*, *Eupatorium paucibracteatum*, *Pleurothallis* espéc. div., *Microlepanthes* espéc. div., etc.

Asociaciones estudiadas:

Ilici turquinensi-Myricetum cacuminis Borhidi y Muñiz ass. n.
Agavo pendentatae-Mitracarpetum acunae Borhidi y Muñiz ass. n.

27. Clase: **CLUSIO-ILICETEA** Borhidi y Muñiz cl. n.

Matorrales siempreverdes semisecos montanos, que se extienden como sustituyentes del monte nublado en las sierras de serpentina, formados por una flora altamente endémica.

Géneros caracteristicos: *Clusia, Ilex, Schmidtottia, Laplacea, Acrosynanthus, Calyptranthes, Buxus, Dasytropis, Phidiasia, Calycogonium, Pachyanthus, Miconia, Ossaea, Coccoloba, Feddea*, etc.

27.1. Orden: CLUSIO-ILICETALIA Borhidi y Muñiz ord. n.
Caracteres de la clase.

Espécies caracteristicas: *Clusia nipensis, C. monocarpa, C. callosa, C. alainii, C. moaensis, C. grisebachiana, Ilex moaensis, I. shaferi, I. berteroi, I. hypaneura, I. subavenia, Schmidtottia sessilifolia, S. monticola, Laplacea moaensis, L. benitoensis, Acrosynanthus trachyphyllus, Purdiaea microphylla, Buxus crassifolia, B. retusa, B. historica, B. shaferi, Myrica shaferi, Vaccinium shaferi, Shafera cubensis, Feddea cubensis, Coccoloba nervosa, C. oligantha, C. toaensis*, etc.

27.1.1. Alianza: ***Ilici-Laplaceion maoaensis*** Borhidi y Muñiz al. n.
Matorrales siempreverdes humedos montanos en las alturas serpentinosas de las Sierras de Cristal, Moa, Iberia y Toa, entre 600 y 1300 m de altura.
Asociaciones estudiadas:

Ilici-Laplaceetum benitoensis Borhidi y Muñiz ass. n.
Rheedio-Buxetum crassifoliae Borhidi y Muñiz ass. n.
Clusio-Ilicetum shaferi Borhidi y Muñiz ass. n.

REFERENCIAS

ACUÑA, J. G. 1938: Catálogo descriptivo de las orquideas cubanas. — Est. Exp. Agron. Santiago de las Vegas, Bol. No. 60. pp. 221.
ACUÑA, J. G. 1964: Flora de las ciénagas de Cuba. — Poeyana, Ser. A. No. 3. pp. 10.
ACUÑA, J. G.—BORHIDI, A. 1971: Catálogo preliminar de los helechos cubanos. — Manuscrito pp. 30.
ACUÑA, J. G.—PIÑAL, S. C. del,—ACUÑA, O. G. 1967: Catálogo floristico de Isla de Pinos. — Acad. Cien. Cuba, Ser. Isla de Pinos No. 22. pp. 54.
ALAIN, H. LIOGIER 1950: Notas sobre la vegetación de la Loma de Cajalbana, Pinar del Rio. — Rev. Soc. Bot. Cubana **7**, 8—18.
ALAIN, H. LIOGIER 1954: Segunda herborización por el Toa. Exploración del Pico Galano. — Rev. Soc. Bot. Cubana **11**, 87—101.
ALAIN, H. LIOGIER 1956: Exploraciones botánicas en la Sierra del Cristal. — Ibid. **13**, 24—39.

ALAIN, H. LIOGIER 1960: Flora de Baracoa. — Rev. Soc. Geogr. Cubana **30,** 13—22.
ALAIN, H. LIOGIER 1964: Flora de Cuba. Vol. V. Habana. pp. 362.
ALAIN, H. LIOGIER 1969: Suplemento de la Flora de Cuba. — Ed. Sucre, Caracas, pp. 150.
ASPREY, G. F.—ROBBINS, R. G. 1953: The vegetation of Jamaica. — Ecol. Monogr. **23,** 359—412.
BAGNOULS, F.—GAUSSEN, H. 1964: Les climats tropicaux et la végétation. — Adansonia **4,** 262—268.
BEARD, J. S. 1944: Climax vegetation in tropical America. — Ecol. **25,** 127—158.
BEARD, J. S. 1953: The Savanna Vegetation of Northern Tropical America. — Ecol. Monogr. **23,** 149—215.
BEARD, J. S. 1955: The classification of tropical American vegetation types. — Ecol. **36,** 89—100.
BISSE, J. 1974: Nuevos árboles de la Flora de Cuba, I. — Feddes Repert. **85,** 587—608.
BISSE, J. 1975: Nuevos árboles de la Flora de Cuba, II. — Ciencias. Univ. Habana, Ser. 10. Botánica **2,** 1—23.
BISSE, J. 1976: El altiplano de la Mina Ibaria. — Ibid. **9,** 37—39.
BONAZZI, A. 1937: Estudios sobre las turbas de Cuba. — Mem. Soc. Cub. Hist. Nat. **11,** 5—30.
BORHIDI, A. 1973: Fundamentos de Geobotánica de Cuba. (Diss. para el grado a Doctor en Ciencias Biológicas, Budapest, Manuscrito en hungaro) pp. 345. + 13 tablas y mapas.
BORHIDI, A. 1974: Mapificamos en Cuba (en hungaro) Gondolat Kiadó Budapest, pp. 242.
BORHIDI, A. 1976: Fundamentos de Geobotánica de Cuba. (Tesis para el grado a Doctor en Ciencias Biológicas, Budapest, en hungaro) 1—16.
BORHIDI, A.—HERRERA, R. 1977: Génesis, caracteristicas y clasificación de los ecosistemas de sabana de Cuba. — Ciencias Biol. Acad. Cien. Cuba **1,** 115—130.
BORHIDI, A.—IMCHANITSKAYA, N. N.—MUÑIZ, O. 1978: Dendrological novelties in Cuba. — Acta Agron. Acad. Sci. Hung. **27,** 428—437.
BORHIDI, A.—MUÑIZ, O. 1971: New plants in Cuba, I. — Acta Bot. Acad. Sci. Hung. **17,** 1—36.
BORHIDI, A.—MUÑIZ, O. 1975: New plants in Cuba, IV. — Ibid. **21,** 221—230.
BORHIDI, A.—MUÑIZ, O. 1976: Plantas nuevas en Cuba, V; — Ibid. **22,** 295—320.
BORHIDI, A.—MUNIZ, O. 1977a: Myrtaceae novae Cubanae, I. — Bot. Közlem. **64,** 13—22.
BORHIDI, A.—MUÑIZ, O. 1977b: Revisión del género Croton (Euphorbiaceae) en Cuba. — Annal. Hist. Nat. Mus. Nation. Hung. Budapest, **69,** 41—53.
BORHIDI, A.—MUÑIZ, O. 1977c: Adiciones al conocimiento de la Flora Cubana (I). Harpalyce, Banara y Xylosma. — Ciencias Biol. Acad. Cien. Cuba, **1,** 131—145.
BORHIDI, A.—MUÑIZ, O. 1977d: Notas sobre Acantáceas Cubanas, I. Oplonia y Elytraria. — Acta Bot. Acad. Sci. Hung. **23,** 303—318.
BORHIDI, A.—MUÑIZ, O. 1977e: Myrtaceae novae Cubanae, II. — Bot. Közlem. **64,** 211—34.
BRAUN-BLANQUET, J. 1950: Sociologia vegetal. — Acme Agency Soc. de Resp. Ltda. Buenos Aires. pp. 444.
CARABIA, J. P. 1945: Vegetation of the Sierra de Nipe. — Ecol. Monogr. **15,** 324—341.
CIFERRI, R. 1936: Studio geobotanico dell'Isola Hispaniola (Antille). — Atti d. Inst. Bot. Univ. Pavia **8,** 3—336.
CURTIS, J. T. 1947: The palo verde forest type near Gonaives. Haiti, and its relation to the surrounding vegetation. — Caribb. Forester **8,** 1—26.
DANSEREAU, P. 1966: Studies on the vegetation of Puerto Rico I. — Univ. Puerto Rico Spec. Publ. No. **1,** 1—45.
DANSEREAU, P.—BUELL, F. P. 1966: Studies on the vegetation of Puerto Rico II. — Ibid. 46—287.
DAVIS, J. H. 1940: The ecology and geologic role of mangrove in Florida. — Carnegie Inst. Washingt. Publ. **517,** 303—412.
DAVIS, J. H. 1942: The ecology of the vegetation and topography of the sand keys of Florida. — Ibid. **524,** 115—195.
DEL-RISCO, E.—BORHIDI, A. 1975: Estructura del manto vegetal. (en: Informe sobre el estado de los conocimientos relativos a los ecosistemas forestales tropicales de Cuba, bosques perennifolios, semicaducifolios y caducifolios.) Imforme al UNESCO, 23—43.
DEL-RISCO, E.—BORHIDI, A. 1977: El area de Zapata, Cuba; I. Clasificación fitocenologica y descripción de la vegetación. — Manuscrito pp. 48.
GANCHEV, S. P. 1972: Caracteristicas geobotánicas de las comunidades mas extensas de la Reservación Natural de Cupeyal del Norte. — Acad. Cien. Cuba Ser. Forestal **8,** 1—43.

GÓMEZ-POMPA, A. 1973: Ecology of the Vegetation of Veracruz. In: A. GRAHAM (ed.): Vegetation and vegetational history of Northern Latin America. — Elsevier Sci. Publ. Co. New York 73—148.
HADAČ, E.—HADAČOVÁ, V. 1969: The Association Blechno serrulati-Acoelorraphetum wrightii in the Remates de Guane, W-Cuba, and its ecology. — Folia Geobot. Phytotax. **6,** 369—388.
HERNÁNDEZ, A. y otros 1975: Génesis y clasificación de los suelos de Cuba. — Acad. Cien. Cuba, Inst. de Suelos, La Habana, pp. 315.
HOWARD, A. R. 1968: The ecology of the elfin forest in Puerto Rico, I. introduction and composition studies. — J. Arn. Arb. **49,** 381—418.
HOWARD, A. R. 1969: The ecology of an elfin forest in Puerto Rico, II. Studies of stem growth and form and of leaf structure. — Ibid. **50,** 225—262.
HOWARD, R. A.—BRIGGS, W. R. 1953: The vegetation of coastal dogtooth limestone in Southern Cuba. — Ibid. **34,** 88—95.
KERSHAW, K. A. 1968: Classification and ordination of Nigerian savanna vegetation. — J. Ecol. **56,** 467—482.
KNAPP, R. 1964: Höhere Vegetations-Einheiten einiger Gebiete der holarktischen und neotropischen Floren-Reiche. — Geobot. Mitteil. **28,** 1—11.
KNAPP, R. 1965: Die Vegetation von Nord- und Mittelamerika. — Fischer Vrl. Stuttgart-Jena, pp. 373.
KÜCHLER, A. W. 1951: The relation between classifying and mapping vegetation. — Ecol. **32,** 275—283.
LEÓN, H. SAUGET—ALAIN, H. LIOGIER1946—1958: Flora de Cuba I—IV. La Habana.
LINDEMAN, J. C. 1953: The vegetation of the coastal region of Suriname. — Utrecht, pp. 416.
LIPPOLD, H. 1974: Neue Arten aus der Flora Cubas. — Feddes Repert. **85,** 609—628.
LÖTSCHERT, W. 1958: Die Übereinstimmung von geologischer Unterlage und Vegetation in der Sierra de los Organos (Westcuba). — Ber. d. Deutsch. Bot. Ges. **71,** 55—70.
LVOV, J. A. 1967: Pantanos turbosos de Cuba (en ruso). — Izd. ANSSSR. ser. biol. No. 3 (23) pp. 32.
MARIE-VICTORIN, F.—LEÓN, H. SAUGET, 1942, 1944, 1956: Itinéraires botaniques dans l'ile de Cuba — Contr. Inst. Bot. Univ. Montreal No. **41,** pp. 496, No. **50,** pp. 410, No. **68,** pp. 227.
NUÑEZ JIMÉNEZ, A. 1965: Geografia de Cuba. 3ra ed. Edit. Pedag. La Habana pp. 526.
MUÑIZ, O.—BORHIDI, A. 1977: Catálogo de las palmas de Cuba con claves analiticas y descripciones de espécies nuevas. Manuscrito pp. 72.
PONCE-LEÓN, P. de, 1952, 1953, 1954: Evolución de las formaciones vegetales transitorias en Cuba. Rev. Soc. Cubana Bot. **9,** 91—93, **10,** 20—23, **11,** 69—72.
SAMEK, V. 1969: La vegetación de Ia Isla de Pinos. — Acad. Cien. de Cuba, ser. Isla de Pinos, No. **28,** pp. 28. +2 tab.
SAMEK, V. (1972): Los pinares de la provincia Pinar del Rio. 80 pp. + XIII. (manuscrito)
SAMEK, V. 1973a: Pinares de Cajalbana. Estudio sinecológico. Acad. Cien. Cuba, ser. Forestal No. **13,** 1—56.
SAMEK, V. 1973b: Pinares de la Sierra de Nipe. Estudio sinecológico. — Ibid. No. **14,** 1—58.
SAMEK, V.—MONCADA, M.: Comunidades vegetales de las lagunas blancas de Pinar del Rio, Cuba. — Acad. Cien. Cuba, Ser. Pinar del Rio, No. **27,** 1—29. + 11 tab.
SCHUBERT, R.—DANERT, S. 1969: Über die Vegetationsverhältnisse in zwei Naturschutzgebieten Kubas, I. Das Naturschutzgebiet von El Beral. — Arch. Naturschutz u. Landschaftsforsch. **9,** 271—299.
SCHUBERT, R.—DANERT, S. 1971: Über die Vegetationsverhältnisse in zwei Naturschutzgebieten Kubas, II. Das Naturschutzgebiet Gupeyal. — Ibid. **11,** 17—41.
SCHUBERT, R. — HELMECKE, K. — KRUSE, J. — DEL-RISCO, E. — CAPOTE, R. —VANDAMA, R. — OVIEDO, R. — VILAMAJÓ, D. — MENENDEZ, L. (1979): Ergebnisse der Expedition von Wissenschaftlern der Akademie der Wissenschaften Kubas und der DDR zur Isla de Pinos (Kuba) 1975. I. Ergebnisse geobotanischer Untersuchungen in den Mogoten El Abra und Bibijagua. — Feddes Repert. **89,** 601—628.
SCHUBERT, R. — HELMECKE, K. — KRUSE, J. — DEL-RISCO, E. — CAPOTE, R. — VANDAMA, R. — OVIEDEO, R. — VILAMAJÓ, D. — MENENDEZ, L. (1979): Ergebnisse der Expedition von Wissenschaftlern der Akademie der Wissenschaften Kubas und der DDR zur Isla de Pinos. II. Ergebnisse geobotanischer Untersuchungen in den Pinares von Baños termales del Rosario und Loma la Cañada. — Feddes Repert, **90,** 19—50.

SEIFRIZ, W. 1943: The plant life of Cuba. — Ecol. Monogr. **13**, 375—426.
SMITH, E. E. 1954: The forests of Cuba. — Maria Moors Cabot. Found. Publ. **2**, 1—98.
SOÓ, R. 1964: Synopsis systematico-geobotanica Florae Vegetationisque Hungariae. I. — Akad. Kiadó Budapest pp. 848.
STEHLÉ, H. 1945: Forest Types of the Caribbean Islands. Part I. — Caribb. Forest. **6**, Suppl. 273—414.
TAYLOR, B. W. 1963: An outline of the Vegetation of Nicaragua. — J. Ecol. **51**, 27—54.
Van DONSELAAR, J. (1965): An ecological and phytogeographic study of northern Surinam savannas. In.: Lanjouw, J. — Versteegh, P. J. D. (ed.): The Vegetation of Suriname. Ed. van Eedenfonds, Amsterdam, Netherlands.
WADSWORTH, F. H. 1954: Tropical rain forest. — The Dacryodes—Sloanea associacion of West-Indies. — Act. du IV^{e} Congr. Forest. Mond. **3**, Dehre Dun.

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CYTOCHEMICAL INVESTIGATIONS OF THE SHOOT APEX OF APPLE TREES II. DNA-CONTENT OF NUCLEI OF MERISTEMATIC CELLS, DEPENDING ON DIRECTION OF SHOOT GROWTH AND MORPHACTIN PRETREATMENT

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This paper is concerned with the cytophotometrically detectable changes in DNA level of cell nuclei within the tips of shoots treated as below. Investigations were carried out in apices of long shoots grown vertically (V), horizontally (H), vertically and then bent horizontally (VH). A proportion of these (V, H, VH) shoots received morphactin pre-treatment, too. Both bending shoots horizontally and spraying morphactin are known to promote flower bud formation. — There was a higher DNA-content in nuclei of the apex growing horizontally than in that growing vertically. Within the shoot tip growing horizontally the DNA-level was slightly increased in the lower (toward to the earth situated) side of the apex. The morphactin tended to decrease the DNA-content of the shoot tip, and to diminish differences between the upper and lower side of the apex growing horizontally.

Introduction

Bending shoots of apple trees is one of the most usual methods practiced in the fruit production. Forcing the vertically growing shoots into a horizontal position changes growth rate and degree of ramification and flower bud formation. Gravity, of course, has a well-known direct effect on apical dominance and on flower formation, similarily to other fruit trees and woody plants (see review by JANKIEWICZ 1971).

Spraying with growth regulators of the morphactin type in a concentration of 100 ppm or higher leads to partial loss of direction in shoot growth (BUBÁN et al. 1969). Loss of geotropic sensitivity of plant organs was reported by KHAN (1967) and also by KRELLE and LIBBERT (1968b).

Some information will be given here on the cytophotometrically detectable changes in DNA level of cell nuclei within the shoot tips treated in both way mentioned above. Results of ultraviolet microscopy of starch grains in histological sections prepared from the same shoot tips have been published formerly (BUBÁN and ZELLER 1975).

Material and Method

Plant material: The plant material (Jonathan variety on M 4 rootstock) was obtained from an apple orchard of the Institute of Pomology at the University of Hohenheim. Tips from shoots growing in three different orientations were used:
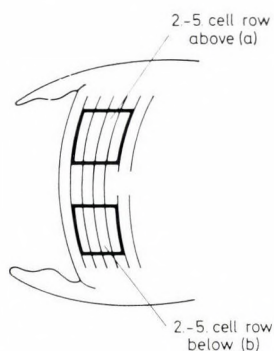
Fig. 1. **Shematic representation of the investigated meristematic regions of horizontally grown long shoots**
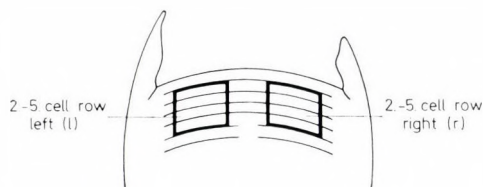
Fig. 2. **Shematic representation of the investigated meristematic regions of vertically grown long shoots**

1) shoots growing vertically upwards (V),
2) shoots originally growing vertically but tied down horizontally (VH),
3) shoots growing horizontally (H).

The VH shoots were tied horizontally at the time of the morphactin treatment (4th of July).

Morphactin treatment: Half of the shoots (experimental shoots VM, VHM, HM) were treated with morphactin (= chloroflurenol, 30 ppm). The two young leaves next to the growing point were dipped for a few seconds into the morphactin solution. The treated young leaves had approximately half of the surface area of fully developed leaves. Six shoots were treated identically and constituted one experiment.

DNA assay: Three days after the treatment, the shoot tips (2 cm long) were cut and brought into the laboratory. During transport, preparation and fixation, the cuttings were kept in their original position (vertical or horizontal). Ethanol : formalin : picric acid 6 : 1: 1.3 was used for fixation. The 10 to 12 micron thick sections prepared after embedding in paraplast were treated as it is known for FEULGEN-procedure. The SCHIFF reagent was prepared according to the standard technique of GRAUMANN (1953), but with trichloro acetic acid (BLOCH and GODMAN 1955). Hydrolysis occurred in 5N HCl at room temperature for 55 min. The reliability of the longer hydrolysis time was confirmed by earlier methodical studies (HESEMANN and BUBÁN 1973). Measurements in certain zones of the apex (see Figs 1 and 2) were carried out by UMSP-I universal microspectralphotometer (ZEISS), the data have been expressed as AU (arbitrary units).

Results

Longitudinal sections of long shoots (LS) were used to measure cytophotometrically the DNA content of meristematic cell nuclei of the apex. In this paper only measured values of the nuclei of the cell rows 2—5 were

Table 1

Effect of growth direction and morphactin treatment on the DNA content of shoot apex cells

Samples	Growth direction of long shoots	Pre-treatment with morphactin	Treshold value	DNA content of nuclei in AU					
				cell	rows	below	cell	rows	above
				n	$\bar{x}$	s	n	$\bar{x}$	s
I.	H	—	0.10	17	18.53a	5.69	15	16.98	4.82
II.	H	+	0.10	18	16.45	4.43	21	16.60	5.64
				cell rows left			cell rows right		
III.	VH	—	0.10	16	14.35b	4.08	17	13.82	4.06
IV.	V	+	0.10	15	14.48c	2.92	18	14.58	4.81
V.	V	—	0.10	12	13.68c	3.03	14	16.80	6.25

Remarks: 1. H = horizontally.
2. V = vertically.
3. AU = arbitrary unit.
4. Cell rows below and above, resp.: see Figs 1 and 2.
5. "b" and "c", resp., are significant at 5% and 1% level in comparison to "a".
n = number of nuclei investigated.
$\bar{x}$ = average.
s = standard deviation.

included (Figs 1 and 2). Samples of the experiment are shown in outline in Table 1.

The DNA values show only very little differences within and between the samples of experiments I—V, except sample I. The mean values of this sample, especially the value of the cell rows below, is higher than the values of all other samples. On the other hand, the morphactin tended to decrease the DNA content of the shoot tip, and to diminish differences between the upper and lower side of the apex growing horizontally. Nevertheless, the data of these morphactin effects are insignificant.

The statistic analysis on the comparison of the mean values is represented in Table 1. On the grounds of these statistics, the results are very distinct: Only the cell rows below sample I show — compared to the cell rows of samples III, IV and V — significant differences. Within and between all other samples no significant differences have been found between both sides of the cell rows, independently of the direction of the growth of the shoots and the pre-treatment with morphactin.

The differences of the DNA values are illustrated in a distribution of frequencies as in Table 2. In this frequency table both the DNA values of the single nuclei of meristematic cells and the areas of the nuclei were included. On the basis of the frequency table it can be concluded, that only in the horizontally grown shoots the majority of the meristematic nuclei was in the

Table 2

Frequency distribution of DNA values after Feulgen-staining and grouping of the nuclei in area classes

Classes of areas of the nuclei (in relative area units)	Classes of DNA — content of the nuclei in AU (Arbitrary Units)									
	5.00—7.49	7.50—9.99	10.00—12.49	12.50—14.99	15.00—17.49	17.50 —19.99	20.00—22.49	22.50—24.99	25.00—27.49	27.50—29.99
20.00—29.99			1 0							
30.00—39.99			1 1	2 2						
	0 1	1 0	0 1							
40.00—49.99			0 1	2 3	1 1	1 0	1 2			
			2 4	2 2	1 1					
50.00—59.99				2 1		2 1		0 1	1 1	1 0
		1 0	1 2	5 2	0 2					
60.00—69.99								1 1		
							1 1			
70.00—79.99										1 0
							1 0		0 1	

Remarks: 1. The 1st row of values within the same class belongs to sample I, and the 2nd row of values within the same class belongs to sample III.
2. DNA values of cell rows below or left (in long shoots H and V, VH, resp.) can be seen to the left within a pair of figures in the same class, the values of the upper or right cell rows are to the right.

replication phase (see also the methodical study by HESEMANN and BUBÁN 1973).

Data on nuclei acid and histone level in apices of terminal buds (being induced or inhibited as regards flower primordia initiation) are described in the first part of this paper (BUBÁN and HESEMANN 1979).

Discussion

The present work was intended to give some data on changes in direction of shoot growth altered by treatments. Namely, on the third day after the treatment, the tips of the control shoots which were tied horizontally (VH) curved slightly upwards. The experimental shoots tied down (VHM) gave no uniform reaction: One tip curved slightly upward, a second one vertically upward, and the rest remained in the horizontal orientation. These results are in agreement with the observations of BUBÁN et al. (1969) mentioned above, indicating that there exists no definite direction for shoot tip growth. The tips are still capable of growing by elongation, but lose their sensitivity for gravity.

In our opinion, a cross-transport of endogenous growth regulators should be attained followed by changes in nucleic acid metabolism, shortly after altering the shoot position. This succession of physiological events and its role in controlling geotropic responses is well known. Publications have appeared on growth substances and geotropic curvature as well as differential growth in root tips, respectively (Hager 1971; Pilet 1971a, b; Shaw and Wilkins 1973). Geotropic reaction with special respect to the interactions between auxin, RNA concentration and RNase activity were studied too (Pilet and Nougarede 1970).

The data of measurements presented above may us speculate on a similar relationship. It is worth mentioning certainly, the interesting finding reported by Barlow (1973). He observed on St. Julien plum that the curvature reaction of shoots is slightly reduced after removal of leaves and largely diminished by removal of the shoot tip. The curvature is almost entirely hindered by the two treatments applied simultaneously. However, when the stump of the shoot is supplied with synthetic auxin, and gibberellin was given to the petiole stump, the disposition for curving recovers. In the case of apple rootstock M 7 the removal of leaves and shoot tips had less effect. Furthermore, also the phenomenon of "geotropic memory" of shoots and whole plants of *Populus* and *Malus* species (Borkowska 1966; Borkowska et al. 1967), can be explained by redistribution of growth substances, occurring in several subsequent steps (Jankiewicz 1971; Hager 1971).

Morphactin tended to decrease the DNA level in nuclei of shoot tips, and to diminish differences between the upper and lower side of the apex growing horizontally (see Tab. 1). It could be attributed to the morphactin effects exerted on auxin transport and auxin level, respectively. Inhibition of polar auxin transport is one of the earliest observations from experiments with morphactins (Krelle and Libbert 1968a; Tognoni and Alpi 1969; Treichel 1971), investigating this effect in shoots of apple trees, too (Bubán and Sági 1976). Moreover, cross-transport of IAA is inhibited by morphactins (Bopp, 1972), the auxin transport is hindered by various morphactins considerably, but to a different degree (Pilet 1970, Kaldewey 1973). A lower level of IAA in tissues treated with morphactin was reported first by Ziegler et al. (1969), later it proved to be quite a general effect observed in trials with many species. An enhanced IAA-oxidase activity in young leaves situated near to the shoot tip of morphactin treated apple trees was published previously (Bubán and Sági 1976). Although, a morphactin treatment results in promoted RNA synthesis in the disc of bean leaves (Pozsár and Gracza 1968), in contrast with this there was a lower rate of RNA synthesis in leaves and buds (Schmidt 1974) and, a lower level of nucleic acids in nuclei of apices of apple trees (Bubán and Simon 1978). Data summarized in Table 1 are in accordance with these findings.

REFERENCES

Barlow, H. (1973): Geotropic curvature — Rep. E. Malling Res. Stn. for 1972, 96.

Bloch, D.—Godman, G. (1955): A microphotometric study of the synthesis of desoxyribonucleic acid and nuclear histone — J. biophys. biochem. Cytol. **1,** 17—28.

Bopp, M. (1972): Personal communication.

Borkowska, B. (1966): Gravimorphism in young apple trees: sensitivity to gravity stimulus during dormancy and growth — Bull. Acad. Pol. Sci. Cl. V. **14,** 563—567.

Borkowska, B.—Jankiewicz, L.—Srzednicka, W. (1967): Gravimorphism in apple and poplar trees — Wiss. Z. d. Univ. Rostock **16,** 561—62.

Bubán, T.—Porpáczy, A. Jr.—Sági, F. (1969): Die Wirkung von Morphaktinen auf die vegetative Entwicklung und Blütenbildung von Apfelbäumen — Deutsch. Bot. Ges. Neue Folge, **3,** 161—166.

Bubán, T.—Zeller, O. (1975): Ultraviolet fluorescence microscopy of starch grains in shoot tips of untreated and morphactin treated apple trees — Acta Bot. Acad. Sci. Hung. **21,** 1—7.

Bubán, T.—Sági, F. (1976): The mode of action of the chemicals regulating flower bud differentiation. — Fruit Sci. Rep., **3,** 1—8.

Bubán, T.—Simon, I. (1978): Cytochemical investigations in apices of apple buds with special respect to the flower initiation — Acta Horticult. **80,** 193—198.

Bubán, T.—Hesemann, C. U. (1979): Cytochemical investigations of the shoot apex of apple tress I. DNA, DNA- and RNA, and histone content of meristematic cells' nuclei in terminal buds of spurs with and without fruits — Acta Bot. Acad. Sci. Hung. **25.** 53—62.

Graumann, W. (1953): Zur Standardisierung des Schiffschen Reagens — Z. f. wiss. Mikr. **61,** 225—226.

Hager, A. (1971): Das differenzielle Wachstum bei photo- und geotropischen Krümmungen — Ber. Deutsch. Bot. Ges. **84,** 331—350.

Hesemann, C. U.—Bubán, T. (1973): Methodik cytochemischer Analysen bei pflanzlichen objekten I. Cytophotometrische Bestimmungen des Kern-DNS-Gehalts von Apfelknospen-Schnittpräparaten bei unterschiedlichen Fixierungs- und Hydrolysebedingungen — Histochem. **36,** 237—246.

Jankiewicz, L. (1971): Gravimorphism in higher plants — In: Gordon, S.—Cohen, M.: Gravity and the organism, Univ. Chicago Press, Chicago 317—331.

Kaldewey, H. (1973): Transport and metabolism of indoleacetic acid as influenced by morphactins — 3rd Symp. Accum. Transl. Nutr.-s and Reg.-s in Plant Org.-s Warsawa, May 14th—18th.

Khan, A. (1967): Physiology of morphactins: effect on gravi- and photoresponse — Physiol. Plant. **20,** 306—313.

Krelle, E.—Libbert, E. (1968a): Inhibition of the polar auxin transport by a morphactin — Planta **80,** 317—320.

Krelle, E.—Libbert, E. (1968b): Are morphactins specific or nonspecific blockers of tropisms? — Experimentia **24,** 293—294.

Pilet, P. (1970): Morphactins, growth and auxin transport — Experientia **26,** 608—609.

Pilet, P.—Nougarede, A. (1970): RNA, structure, infrastructure et geotropisme radiculaires — Physiol. Vég. **8,** 277—300.

Pilet, P. (1971a): Root cap and georeaction — Nature New Biol. **233,** 115—116.

Pilet, P. (1971b): Role de l'apex radiculaire dans la croissance, le géotropisme et le transport des auxines — Ber. Schw. Bot. Ges. 81, 52—65.

Pozsár, B.—Gracza, P. (1968): A flurenol származékok és a gibberellinsav nukleinsav szintézisre és szervfejlődésre gyakorolt hatása. (Effect of fluorenol derivates and ghibberellin acid on the synthesis of nucleic acid and on the development of the organs.) — 10. Biokém. Vándorgy. Esztergom, aug. 26—28.

Schmidt, S. (1974): Personal communication.

Shaw, S.—Wilkins, M. (1973): The source and lateral transport of growth inhibitors in geotropically stimulated roots of Zea mays and Pisum sativum — Planta **109,** 11—26.

Tognoni, F.—Alpi, A. (1969): Morphactins, auxin transport and apical dominance in Pisum sativum — Deutsch. Bot. Ges. Neue Folge **3,** 53—60.

Treichel, S. (1971): Über Umsetzungen und Wirkungen von Morphaktinen in höheren Pflanzen — Diss., Fak. Chem. Biol. Geol. Mineral. der Techn. Hochsch., Darmstadt.

Ziegler, H.—Wogt, L.—Treichel, S.—Streitz, B. (1969): Zur physiologischen Wirkung der Morphaktine — Dtsch. Bot. Ges. Neue Folge **3,** 43—51.

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LIGHT AND PIGMENTS INVESTIGATIONS ON SPECIES IN A HUNGARIAN BEECHWOOD

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The author carried on light intensity measurements in the understory — herb-layer of *Melitti-Fagetum* and determined the photosynthetic pigment content (chlorophyll a, b, carotinoids) and concentration in the leaves of dominant herb-layer species, according to aspects and seasons. The early spring-time geophyta that live in light-intensive period — *Anemone ranunculoides, Dentaria enneaphyllos, Coridalis cava* possess high pigment level and chlorophyll a/b ratio. The pigment concentration of the hemicryptophyton species of the herb-layer — *Oxalis acetosella, Galium odoratum, Viola silvestris, Carex pilosa* — in the spring period of better light intensity is low, while in the summer period of low light intensity it is high. As a result of the balanced light intensity conditions of the summer months, the pigment concentrations of the populations of different species are identical. Their chlorophyll a/b ratios are very small, and light-ecologically fixed, during the whole year.

Introduction

The exploration of the structure and function of natural communities both theoretically and in practice is one of the fundamental aims of modern scientific research. The long-term, optimal utilisation of natural forests is a biological and social interest of prime importance, which must have been organized carefully. The Ministry of Agriculture and Food and the Academy Committee of Veszprém support the complex research "Studies in Forest Ecosystems" which belongs to the Third Programme of the CMEA. We join to this complex research with our light investigations and the examinations of the photosynthetic pigment structure, by a closer analysis of the relationship between biotic and abiotic factors.

The forest is a community of many components, an ecological system which is in close relationship with environmental factors having on it. Its basic characteristic is its hierarchic organization of high degree, which is maintained for a long time by the regulatory mechanisms.

In the ecosystems, as open systems, the basic connexion between biotic and abiotic factors is the functional unity of the autotrophic plant component with light. The aim of our forest ecological research covering light and pigment examinations is to analyse this functional unity. Assumably, in the lower level of the stratified plant community, there exists a close relationship between the quantity and the distribution of light and of the photosynthetic pigments. The aim of our examinations is to explore this relationship and its seasonal dynamics, through the determination of the photosynthetic pigment of the dominant species of the herb-layer, and by tracing the light conditions. Our results and data provide a basis for the examination of the photosynthetic function of herb-layer plants.

The first examinations of the production-ecological approach of supraindividual level of the relationship between light and photosynthetic pigments were done water ecosystems

(GESSNER 1949). E. P. ODUM (1971), H. T. ODUM and co-workers (1958), as well as their followers interpreted the productivity of aquatic and terrestrial ecosystems in the function of pigment concentration. Studies on the pigment structure of forest plant communities their mathematical modelling as well as their simulation by computer technique is the merit of primarily Japanese researchers (cf. IBP 3. ed. J. P. COOPER, 1975).

The ecological role of light in forest communities is dealt with in almost all of the research fields of forest ecosystems (in Central-Europe at present, for example, in SOLLING (co-ord: H. ELLENBERG); in Fontainebleau (co-ord: G. LEMÉE); Monte Terminillo (co-ord: V. Giacomini); Central Reztocze (co-ord: IZDEBSKI); etc.

The examination with a similar aim, from an ecological aspect, of the deciduous and the evergreen forests of Eastern-Europe is linked with the name of ZELLNIKER (1967, 1968, 1969) and GORYSINA (1969, 1975).

The reactions, behaviour on individual and associations level (agricultural culture!) of plants in relation to light are examined in the schools of Estonian biophysicist, biomathematicians, and theoretical ecologists (A. LAISK, H. MOLDAU, T. NILSON, J. ROSS, H. TOOMING, etc., in ROSS 1975).

In Czechoslovakia, several research centres have been set up for forest ecological examinations (Prague, Bratislava, Zvolen). While by these days the Prague school (for example, ČATSKY 1978 etc.) took primarily a physiological and biochemical trend, in Bratislava the forest ecological examinations in the fields continue to be dominant (M. DUDA—E. MASARIVICOVA 1978). The North-European States contribute primarily to the research into the ecology of evergreen forests (for example, Lund, Uppsala, B. AXELSSON 1976).

On the basis of the common objectum (*Pinus silvestris*), the research works related to the relationship between photosynthesis and light can also be put into this category. One of the central problems is the question of artificial light sources approximating natural ight (ZELAWSKY and co-workers 1973, 1976).

In Hungary, the ecological research into the relationship between light and pigment in natural forest communities was begun by FEKETE (Buda Hills, 1974), and JAKUCS and co-workers (Síkfőkút Project 1973).

Research area and method

The forest ecological examinations were carried on in the 102 year old *Melitti-Fagetum* stand at Farkasgyepü (MAJER 1976), which is at the same time the common research area of the Forest and Wood-Industrial University of Sopron, the Ministry of Agriculture and Food, and the Academy Committee of Veszprém.

The beechwood decorates on a leached brown earth which developed on a loess parent material settled on limestone. The annual average of precipitation is 866 mm, with on early-summer maximum, on the basis of data collected in the last 50 years at Farkasgyepű; the annual mean temperature is 8.9°C, the annual mean fluctuation of the temperature is 21°C, the number of foggy days is 35. The balanced temperature, the quantity of precipitation the time of its maximum indicate a subatlantic climatic effect. Under this influence, the *Melitti-Fagetum* is already zonal at an altitude of 300 m.

Light measurements. — We measured the light intensity at constant points assigned in advance in the herb layer of the forest, at a height of 30 cm, with a LANGE-type lux meter placed horizontally. To estimate the relative light intensity, synchronous recording was carried on the nearby clearing with a PU 150 lux meter. The reading-off was carried on at maximal sun height, at noon-times. In spring, in the period of foliation, measurements were carried on often (by 10 days), in other periods by 3—4 weeks.

The determination of photosynthetic pigments. By taking the basic seasonal dynamics of the forest into consideration, we took the leaves of possibly identical age and state of the dominant sward-forming species in the main aspects, between 9 and 11 in the morning. Discs of known diameter were cut of the leaves with a corkscrew. One half of the material was then processed in a laboratorium, the other half was put aside to determine the dry weight. By

species, 20 leaf discs (from 20 leaves of 20 plant individuals) were taken as a sample; this was repeated 3 times (60 discs). The sampling was repeated by species 3 times in spring (180 discs), while in summer and autumn twice (120 discs).

The 20 discs were homogenised in braying mortar, containing little cc. aceton with the addition of a small quantity of $MgCO_3$, and — if necessary — pure sand. The material was then glassfiltered (G_4), photometred by Spekol photometer chlorophyll-*a* at 662 nm, chlorophyll-*b* at 646 nm, carotenoids at 440,5 nm. The calculations were carried out after WETTSTEIN (1957). The pigment values were related to the dry weight of the leaf and to an area of 100 cm². The plant species selected for the examinations were the dominant geophyta at spring time: *Anemone ranunculoides, Dentaria enneaphyllos, Corydalis cava;* and species forming facies in a major part of the year; *Oxalis acetosella, Galium odoratum, Viola silvestris, Carex pilosa,* and the summer time *Circaea lutetiana.*

Sampling times: March 29, 30, April 27, 29, 30, May 3, 5, June 26, 27, 29, 30, September 7, 8 in 1977.

Results and Discussion

The green mass containing photosynthetic pigments in beechwoods divides into a total of two large basic layers, *viz.* the plastically closed canopy exposed to light, and absorbing it, and the herb layer, which lives in the domain of low light intensity. By the evidence of our light intensity measurements, it is 1—2 % of the total light intensity in summer which comes to realization in the herb-layer of the beechwood. Assumably, the characteristic, extreme light climate of the herb-layer must have an influence also on the values of the pigment content of the living component. For this purpose, the photosynthetic pigment analyses of the dominant sward-forming herb-layer species were put on the project. Similar examinations were also carried out previously in other beechwood in Hungary (Pilis Hills, Vöröskő, by DRASKOVITS 1975; DRASKOVITS and FEKETE 1976).

A certain emphasis put on the examinations of the herb-layer of forests is not of a novel character. Since the beginning of the century — CAJANDER and his followers — forest typology proved useful for practice in forestry through the recognition of the role of plants which live in the herb-layer as indicators of habitat. MAJER (1952) also applies this investigation in beechwood in Hungary.

We extended our photosynthetic pigment examinations, beyond the usual chlorophyll examinations also to that of carotenoids.

The summarisation of the light intensity measurements is given in Table 1; the values of the photosynthetic pigment concentration of dominant herb-layer species (mg pigment/1 gr dry matter) are given in Table 2; the pigment content values (mg pigment/100 cm² of leaf area) are to be found in Table 3.

The definite tendencies of the values of chlorophyll contents related to leaf area are to be emphasized (Table 3);

(1) during the vegetation period, the quantity of all chlorophyll components increases, showing an autumn maximum;

(2) the chlorophyll content of the geophyta growing in early spring-time surpasses to a great extent that of the hemicryptophyta growing 4—5 weeks later at spring-time.

The concentration values of total chlorophyll and carotenoid in the species examined are given in Fig. 1, those of chlorophyll a and b concentration in Fig. 2.

Table 1

Light intensity values in the herb-layer of a beechwood at Farkasgyepű, based on the average values measured in the years 1976—77—78

	Light intensity in 10^3 lux		Relative light intensity in %	
	clear	cloudy	clear	cloudy
Early spring March 10—29	20—24	9—12	52	48
Spring April 28—May 7 foliation	8.6	3.2	13	12
Summer June 17—August 5	0.8	0.4	1.0	1.5
Autumn September 7—17	2.9	2.4	9	6

Table 2

Photosynthetic pigment concentration in the leaves of understory species in beechwood (mg/gr dry matter) Farkasgyepű, 1977

	Chlorophyll a mg/g			Chlorophyll b mg/g		
	spring	summer	autumn	spring	summer	autumn
Anemona ranunculoides	8.580			4.258		
Dentaria enneaphyllos	11.049			6.571		
Corydalis cava	10.267			5.679		
Oxalis acetosella	3.328	9.076	9.414	2.641	5.833	6.125
Galium odoratum	4.056	9.038	9.892	2.284	5.899	6.578
Viola silvestris	4.405	9.140	8.637	2.570	5.773	5.105
Carex pilosa	3.753	4.768	5.704	2.239	3.420	3.475
Circaea lutetiana		11.298			7.372	
Galeobdolon luteum		8.797	8.850		5.939	5.637

	Chlorophyll a + b mg/g			Carotenoid s, mg/gr		
	spring	summer	autumn	spring	summer	autumn
Anemone ranunculoides	12.834			2.527		
Dentaria enneaphyllos	17.627			2.881		
Corydalis cava	15.946			2.745		
Oxalis acetosella	5.970	14.908	15.440	1.567	2.340	2.559
Galium odoratum	6.341	14.939	16.471	1.493	2.216	2.409
Viola silvestris	6.976	14.914	13.746	1.476	2.613	2.084
Carex pilosa	5.993	8.185	9.180	1.037	1.110	1.481
Circaea lutetiana		18.672			3.067	
Galeobdolon luteum		14.737	14.488		2.328	3.519

Table 3

The photosynthetic pigment content in the leaves or herb-layer species of beechwood; mg/100 cm² of leaf; Farkasgyepű, 1977

Species	Chlorophyll a mg/100 cm²			Chlorophyll b mg/100 cm²		
	spring	summer	autumn	spring	summer	autumn
Anemone ranunculoides	2.048			1.016		
Dentaria enneaphyllos	2.043			1.217		
Corydalis cava	1.921			1.063		
Oxalis acetosella	0.553	1.293	1.289	0.439	0.830	0.848
Galium odoratum	1.157	2.316	3.152	0.654	1.511	2.096
Viola silvestris	1.413	1.825	2.652	0.819	1.152	1.568
Carex pilosa	1.384	2.453	3.599	0.825	1.760	2.193
Circaea lutetiana	1.429	1.429			0.933	
Galeobdolon luteum		1.805	2.223		1.217	1.581

Species	Chlorophyll a + b mg/100 cm²			Carotenoids /mg/100 cm²		
	spring	summer	autumn	spring	summer	autumn
Anemone ranunculoides	3.064			0.603		
Dentaria enneaphyllos	3.261			0.533		
Corydalis cava	2.984			0.514		
Oxalis acetosella	0.992	2.123	2.137	0.260	0.333	0.354
Galium odoratum	1.811	3.827	5.248	0.427	0.568	0.767
Viola silvestris	2.232	2.977	4.220	0.472	0.522	0.640
Carex pilosa	2.209	4.213	5.792	0.382	0.571	0.937
Circaea lutetiana		2.362			0.388	
Galeobdolon luteum		3.022	3.804		0.477	0.922

The concentration of total chlorophyll related to the dry-matter content of early spring-time geophyta is a high value, at about 15 mg/g. The same value in relation to leaf area is altogether 3 mg/100 cm². In the underwood of the beeches these are the only not definitely shade adapted plants. In their period of flowering, at noon, they receive light of a volume of 20—24 thousand lux, which is about 50% of the total light. Thus, even the completely foliage-less beechwood has a considerable effect of filtering light. We consider the raised chlorophyll concentration of the given species concerned as an adaption to these light conditions.

ZABOTINA (1973) did not experience an increase to such an extent in the chlorophyll concentration of early-spring geophyta. One of the reasons for this is certainly to be found that the plants examined by her grow in mixed oak-wood of entirely different light dynamics, which are lighter, and of different

Fig. 1. **Chlorophyll (a + b) and carotenoid concentration in the leaves of species of the herb-layer of beeches (mg/gr dry matter). Farkasgyepű, 1977**

Fig. 2. **Chlorophyll concentration in the leaves of herb-layer species (mg/gr dry matter)**
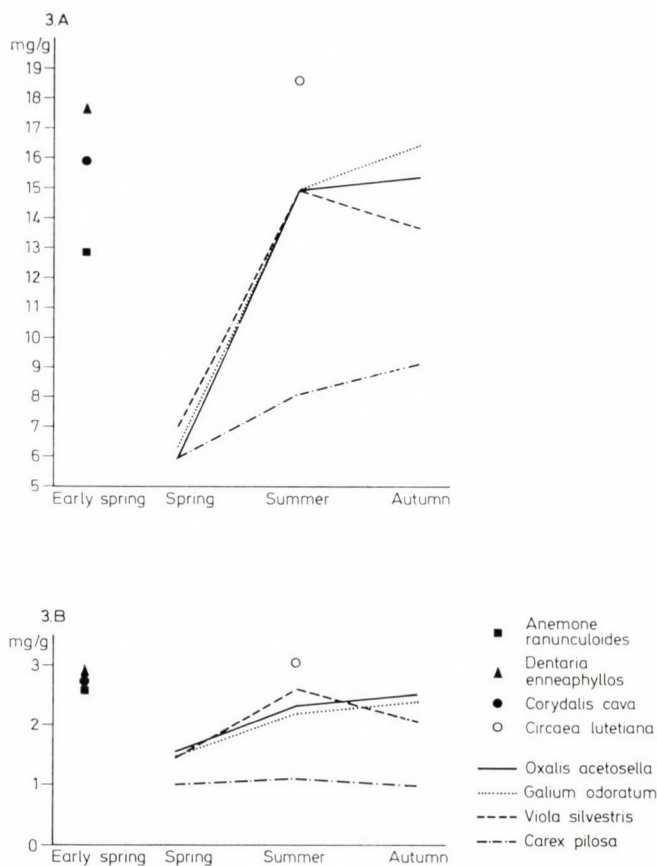
Fig. 3. **Seasonal changes in the concentration of chlorophyll (a + b)-A and carotenoids-B in herb-layer species of beeches**

plant geographical characteristics and species composition, even though part of them does not separate taxonomically from our domestic species.

In the vegetation period, the species following the early spring-time geophyta grow and flower in the underwood of the foliated beechwood, under decreased light conditions (Table 1, Figs 1 and 2).

We found that both the total chlorophyll concentration of the plant species in the two kinds of species groups — early spring time G and spring time H — and the light intensity characteristic at the sampling time are different to a great extent. We consider this phenomenon as an ecophysiological reaction to an abiotic, exterior ecological factor, on the population level. The fact that the above mentioned pigment reaction takes place in the population of even several species, convergently, deserves special attention.

Table 4

Photosynthetic pigment ratios, and the ratio between weight and surface in the leaves of understory species in beechwood Farkasgyepű, 1977

Species	Chlorophyll a/b			Chlorophyll/carotenoids			Dry weight/leaf surface mg/100 cm²		
	spring	summer	autumn	spring	summer	autumn	spring	summer	autumn
Anemone ranunculoides	2.015			5.078			2.38		
Dentaria enneaphyllos	1.680			6.118			2.04		
Corydalis cava	1.806			5.809			1.87		
Oxalis acetosella	1.259	1.555	1.520	3.809	6.379	6.033	1.32	1.42	1.42
Galium odoratum	1.775	1.532	1.503	4.247	6.741	6.837	2.88	2.59	3.18
Viola silvestris	1.710	1.583	1.691	4.726	5.707	6.595	3.20	1.99	2.30
Carex pilosa	1.675	1.394	1.641	5.779	7.373	6.198	3.70	5.16	6.35
Circaea lutetiana		1.532			6.088			1.26	
Galeobdolon luteum		1.481	1.569		6.330	4.125		2.07	2.30

In the course of analysing the total chlorophyll concentration of early-spring geophyta, also the question of quick life rhythm was raised as a possible factor influencing the chlorophyll concentration (see later).

Attention was paid during the whole vegetation period to the pigment concentration in the leaves of the dominant facies-forming species of the beechwood at Farkasgyepű Figs 1, 2 and 3.

The chlorophyll concentrations average of the measured at the time of the spring sampling at the end of April is 5—6 mg/g. This value corresponds to the data given in the literature (I. Maróti 1976). The *Oxalis*, *Galium*, *Viola*, *Carex* species quartet with the exception of *Carex pilosa*, shows very similar values of chlorophyll concentration. The chlorophyll concentration values of *Carex pilosa* are smaller (this difference does not refer to leaf areas; Table 3). The lower chlorophyll concentration of *Carex pilosa* is a consequence of the anatomical characteristic of the strongly sclerenchymatic leaf, a species characteristic which manifests itself well in the ratio of weight and area of the leaves (Table 4).

The chlorophyll concentration values of the herb-layer species of the beechwood examined take a characteristic curve in summer, when we measured at least twice as much chlorophyll concentration as in spring. In this tendency, along with the infraindividual phenomenon of the increase in pigment related to the ontogenesis of leaves, in our opinion also a reaction of supraindividual level given to the change in an external environmental factor — light intensity — is manifested. Light intensity in the herb layer of the entirely foliated

beechwood is very low in summer, 700 lux on the average, 1% of the total light, which can mean the lower limit of light intensity from the viewpoint of the occurrence and flowering of the given species (FILZER 1940). This climate of low light intensity practically does not change during the two and a half summer months, and owing to the plastically closing, homogeneous canopy of the beechwood, its horizontal variability is also negligably small.

The homogeneity of the summer light climate characteristic of the herb-layer in the beechwood appears pregnantly in the level of pigment structure in the living component; the surprisingly identical chlorophyl concentration of the species examined is a reflexion of this phenomenon (Figs 1, 2 and 3). All the chlorophyll components in *Oxalis*, *Galium* and *Viola* are of almost identical concentration; the species reaction of *Carex pilosa* which shows different values has been discussed above.

The species of quick growth which are leafy only in summer, thus begin their vegetative period late and finish it earlier, are of a different growth dynamics. They were represented in the beechwood at Farkasgyepű by *Circaea lutetiana* in a considerable quantity and cover. The chlorophyll concentration of *Circaea* surpasses that of all the species examined during summer. Thus, in our experience, the species of rapid life rhythm (early spring geophyta, see above and the *Circaea*) possess high chlorophyll concentration. The summer chlorophyll concentration values of *Galeobdolon luteum* the homogeneous species trio, viz. *Oxalis*, *Galium* and *Viola*.

By the time of the autumn sampling, the homogeneity experienced in summer period in respect of the chlorophyll concentration of the species examined came to an end. As a consequence of the reduced altitude of the sun, the quantity of the light falling laterally to the herb-layer of the forest is larger, which led to greater differences in light intensity even under the still homogeneously closed canopy. This, and also the spectral alteration in light can be the cause of the autumn changes in the chlorophyll concentration. The chlorophyll concentration of the species, in comparison with the summer level, continued rising (Table 2, Figs 1 and 3). *Carex pilosa* also followed this trend, but to a smaller extent.

Considering the fact that similar examinations took place in respect of domestic forest community (TUBA 1977), it seems reasonable to compare the results, even though the two forests are very different both plant-geographically and ecologically. The turkey oak forest of Eger-Síkfőkút, *Quercetum petraeae-cerris*, is a mixed oak forest of central range of hills, with a definite pannonian-continental-submediterranean character (M. PAPP and JAKUCS 1976). The *Melitti-Fagetum* of beech dominance, at Farkasgyepű is a habitat with balanced climate, and of sub-atlantic character, without any continentality (MAJER 1976). The chlorophyll concentration values related to the species of the herb-layer and shrub-layer in the turkey oak wood of Síkfőkút (the two

layers were contracted by the author on a light ecological basis) assumably are far lagging behind those of the underwood of the beechwood (2—4 mg/g summer). The two forests are different from each other also with respect to the degree of their light intensity and its seasonal changes (L. NAGY 1976). Therefore, a comparison between the herb-layer species of different taxonomy is justifiable only in case of drawing very general conclusions: in the herb-layer
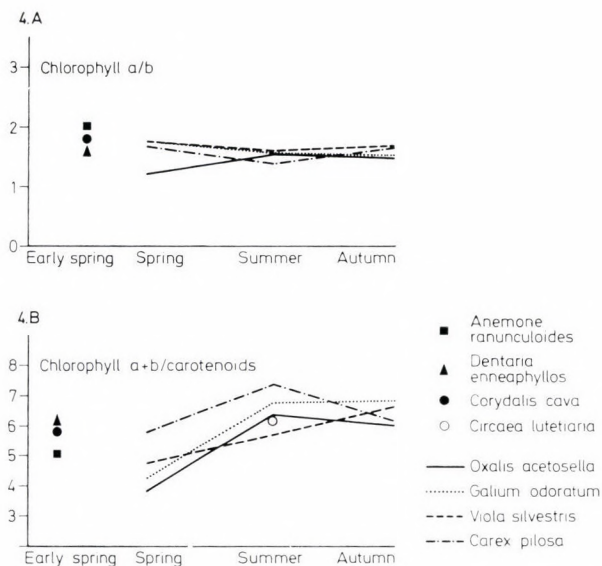
Fig. 4. Seasonal changes in the pigment ratios of herb-layer species in beeches. A: chlorophyll a/b; B: chlorophyll/carotenoids

of very low light intensity of the beechwood with more closed canopy, the chlorophyll concentration of the species becomes enriched to a considerable extent.

Since the dynamics of the chlorophyll-a concentration values is identical with that of the total chlorophyll content discussed so far, we deal with them in no detail.

Chlorophyll-b is an important ecological factor of the habitats with very reduced light intensity of stratified plant communities. The chlorophyll-b concentration values of the species of the beechwood herb layer at Farkasgyepű are given in Table 2 and Fig. 2. Similarly to the values of the total chlorophyll content, those of chlorophyll-b are higher in early spring geophyta, than in spring hemicryptophyta, in which however the chlorophyll content becomes enriched by the summer and by this time it reaches the level of chlorophyll

content found in early spring geophyta. It further rises to a small extent by autumn. The remarkable summer rise in chlorophyll concentration can be an ecological reaction of the species living in the area with minimum light intensity.

Under natural conditions, in organised plant communities, the chlorophyll a/b ratio provides useful ecological information on both the individual plant populations, and on some layer of the community, resp. on its whole. The chlorophyll a/b ratio of the herb layer species of beechwood is indicated in Table 4 and Fig. 4.

The physiological chlorophyll a/b ratio is a value around 3.0; with very high fluctuation; depending on the light-ecological conditions, it can be 1—5, which is still considered as a physiological fluctuation. All the species in the herb layer of beechwood are of a small chlorophyll a/b ratio, typical shade adapted plants, with an extremely small extent of fluctuation; the extreme values, all the populations and the complete vegetation period considered, are between 1.25 and 2.01. This is especially remarkable because the significant light dynamical changes, manifesting themselves seasonally in the herb layer of the beechwood, do not realise in the chlorophyll a/b ratio. We consider the fixed state of chlorophyll a/b ratio, not in for one level, as characteristic for of all the herb-layer species; it is a significant proof of pigment adaptation to light.

It is a general tendency in the beechwood that the chlorophyll a/b ratio decreases from spring to summer — owing to the summer increase in chlorophyll-b — then apart from a few exceptions by the autumn it again increases, thus it is of a summer minimum.

The spring chlorophyll a/b ratio of *Oxalis acetosella*, living in the forest floor, is especially low. Its leaves are of such anatomical, physiological characteristics that are different from those of the species appearing in the comparison. This is convincingly shown by the weight/surface ratio (Table 4). Its pigment level related to leaf area is much lower than that of the other species (Table 3). The development of its leaves begins under the litter. This is why, in our opinion, the chlorophyll-b level is higher, and following from this the chlorophyll a/b ratio is smaller. It can therefore be said that the different a/b values in *Oxalis* are species characteristics.

Carotenoids often appear among photosynthetic pigments in the category of "other" or with some other attributive epithets. This is an indication of the different biosynthesis and role of carotenoids, but at the same time also of the fact that our knowledge related to them is in comparison with the chlorophylls more modest. The role of carotenoids in the process of the photosynthesis is only partly understood. The carotenoids have a dual physiological role. On the one hand the carotenoids by their light absorption protect the light-sensitive photosynthetic apparatus from the photodestruction (Rabinowitch and Govindjee 1969). The carotenoid-deficient mutants i.e. certify the irreversible damage of the photosynthetic apparatus in the experiments both of lower and higher plants — under optimum light con-

ditions (FALUDI-DÁNIEL 1973). On the other hand their function is the energy transport to chlorophylls, which has been lately proved also to the higher plants (TREBST, AVRON, 1977 GOVINDJEE 1975).

After examining the extreme light and chlorophyll concentration characteristics of the herb layer in the beechwood, we paid special attention also to carotenoids in our examinations.

We first of all wanted to survey the quantity relations of the total carotenoid in the species of the herb-layer in beechwood, to trace their seasonal dynamics, then we made attempts to determine the characteristics on a supra-individual level.

The carotenoid content in the leaves of our test plants is shown in Table 3, while the carotenoid concentration in Table 2.

The total carotenoid content and concentration of the species examined move within very narrow extreme values, considering both the individual species and the seasons. The concentration values related to total carotenoid in the literature are similar to the data given in Hungarian literature (I. MARÓTI 1976; TUBA 1977). Considering their annual dynamics, the carotenoid concentration increases very definitely during the vegetation period. This tendency is in agreement with that of the chlorophylls, thus, in the forest community examined, the total pigment content of the species in the herb-layer gradually increases from spring to autumn.

In comparison with the herb-layer of the turkey oakwood of Síkfőkút, the pigment concentration in the leaves of the herb-layer plants of beechwood is higher also in relation to carotenoids than that of the oakwood, both in summer and in the autumn. The rising tendency in the autumn level of carotenoid is common in the herb-layer of the two forests.

During the leaf ontogenesis, the quantity of the carotenoids increases. The extent of the increase in the developing leaves lags behind that of the chlorophyll, while during the aging of the leaf it surpasses that of the chlorophyll. This pigment increase of different extent is reflected by the changes in the chlorophyll/carotenoid ratio (Fig. 4).

After the relatively higher carotenoid concentration of the early spring geophyta the carotenoid concentration of the dominant herb-layer species is of a much lower level. It gradually increases in the later vegetation periods and by the summer it approximates the carotenoid level of the geophyta measured at the end of March. We call attention to the phenomenon also occured in the seasonal dynamics of the chlorophyll concentrations.

In three of the dominant herb-layer species (*Oxalis*, *Galium* and *Viola*) the carotenoid concentration values are very similar and it was only that of *Carex pilosa*, which is relatively separating also in other respects, that proved smaller (Fig. 3). The dynamics of the carotenoid concentration values in *Carex pilosa*, although in its tendency it is in agreement with that of the other three

species, is different in that the greater quantitative gradient is not between spring and summer but between summer and autumn. A part may be played in this by the rhythm of the leaf growth in *Carex pilosa :* the new leaves appearing in spring for a time still live together with the last year's decaying leaves which takes as long as by the beginning of the summer to disappear completely.

As a consequence of the later and more protracted growth of the new leaves, the gradient of the higher carotenoid concentration is thus in comparison with the other three species, which erect their leaves earlier, shifted. Owing to the more remarkable dynamics of the chlorophylls, this phenomenon was not experienced with them. The higher pigment concentration of *Circaea lutetiana* which has leaves only in summer, and is of a shorter life cycle manifested itself also in the case of carotenoids.

The interpretation of the chlorophyll/carotenoid ratio in natural ecosystems is theoretical, hypothetical (owing also to the small number of examinations carried out so far, ODUM, E. P. (1971) pays special attention to the chlorophyll/carotenoid ratio related to aquatic ecosystems), and brings its changes into connexion with the aging of the structures. In the case of forest communities other consideration are also necessary. According to the author, the chlorophyll/carotenoid ratio decreases with aging; this is a consequence of the increase in carotenoids, and it is in connexion with the respiration which is more effective than photosynthesis.

The most striking characteristic of the chlorophyll/carotenoid ratio is the underwood plants of beeches is the homogeneity (Table 4). The same homogeneity, balanced state could be experienced in the chlorophyll a/b ratio, too. The most relevant characteristic of the herb-layer plants of the beechwood examined was the stable, also ecologically fixed state of the pigment ratios, which set in for a given level.

In spite of the movement appearing only in small values the chlorophyll/carotenoid ratio shows a definite seasonal dynamics (Fig. 4), with an expressed summer maximum. The high chlorophyll/carotenoid ratio in summer follows from the relatively reduced presence of the carotenoids. From this summer decrease of the carotenoid — in comparison with the chlorophyll — we inferred that in the herb-layer of the beechwood, which can be characterized as having balanced environmental conditions poor in light, it is in this period that the chlorophylls "need" the least protection of the carotenoids.

Carotenoid concentration	spring $<$ summer $<$ autumn
Chlorophyll a + b concentration	spring $<$ summer $<$ autumn
Chlorophyll/carotenoid	spring $<$ summer $>$ autumn

The above sketch demonstrates that the different extent of the increase in the various pigments changes the chlorophyll/carotenoid ratio.

To think of the supporting role of carotenoids is the most indicated in the early-spring geophyta. Therefore, we could expect — owing to the higher values of carotenoids — here a lower chlorophyll/carotenoid ratio. That this did not even take that course can be explained by the fact that in geophyta the high carotenoid content is accompanied by a very high chlorophyll content. This is in agreement with the quick development of geophyta, with their short above-ground life period, and increased physiological and photosynthetical intensity (GORYSINA 1969, 1975).

In the species of the herb-layer in the turkey oak wood of Síkfőkút, a smaller chlorophyll/carotenoid ratio is characteristic (TUBA 1977). The seasonal changes in the ratio is not expressed, not definite, no tendency can be stated in relation to oakwood. The idea arose that also this phenomenon follows from the more extreme and narrower ecological character of the herb-layer in beechwood.

The examinations of the light intensity conditions and of the chlorophyll and carotenoid concentration occuring in the herb-layer of the zonal hornbeam grove beechwood at Bakony-Farkasgyepű led to the following results:

(1) The herb-layer of the old beechwood with closed canopy is — especially in summer — of a homogeneous, balanced light climate, with strongly reduced light intensity.

(2) The herb-layer species, with the exception of the early spring geophyta, are typical shade-adapted plants, with a relatively large photosynthetic pigment concentration which moves within a narrow interval.

(3) The early spring geophyta separate mainly with their increased photosynthetic pigment level from the dominant species of the herb-layer in beechwood. This different character of the geophyta has probably developed under the ecophysiological effect of the life form-life rhythm and the higher light intensity domain.

(4) The photosynthetic pigment concentration values of the herb-layer in beechwood are several times higher than those of oakwoods in Hungary (TUBA 1977) *and in Eastern-Europe* (GORYSINA 1969, 1975).

(5) The photosynthetic pigment concentration of leaves of the various taxonomical species shows small differences; the smallest ones occur in summer. This is the realization of the uniformity of an inorganic environmental factor— light — in the living component, at the level of photosynthetic pigment.

(6) Pigment ratios, first of all the chlorophyll a/b, are the most fixed values, significant indicators of the adaptation to the environment.

(7) A common characteristic — coming about under the effect of not only exterior environmental factors — of plants with accelerated life rhythm (early spring geophyta, summer Circaea lutetiana) is the raised level of the photosynthetic pigment content.

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REFERENCES

Axelsson, B.—Agren, G. I. (1976): Tree growth model (PT 1)-A development paper. Swedish Coniferous Forest Project. Uppsala, pp. 79.

Čatsky, J.—Ticha, I. (1978): Carbon dioxide compensation concentration as affected by photon flux density during leaf ontogenesis. Programme I/18 CMEA "Optimisation of photosynthetic structures and processes" (in Russian). Paper delivered at the Symposium in Bratislava.

Cooper, J. P. ed. (1975): Photosynthesis and productivity in different environments. IBP. 3. Cambridge University Press Cambridge London New York, Melbourne, pp. 715.

Draskovits, R. M. (1975): Light intensity studies in beechwoods of different ages. Acta Bot. Acad. Sci. Hung. **21**, 9—23.

Draskovits, R. M.—Fekete, G. (1976): Chlorophyll concentration and its ecological significance in some species in beechwoods. Acta Bot. Acad. Sci. Hung. **22**, 29—38.

Duda, M.—Masarovičova, E. (1978): Quantitative analysis of pigments in the relation to internal and environmental factors. Paper delivered at the symposium of Bratislava. CMEA Programme I/18. "Optimisation of photosynthetic structures and processes" (in Russian).

Faludi-Dániel, Á. (1973): Karotinoidmutáns kloroplasztiszok összehasonlító élettana. Bp. Akadémiai doktori értekezés tézisei, mscr. (Comparative physiology of carotenoid-mutant chloroplastics. Bp. Thesis for degree of D. Sc. mscr. in Hungarian.)

Fekete, G. (1974): Interspecifikus kapcsolatok, kölcsönhatások és az ökológiai niche elemzése tölgyerdei fajokon. Akadémiai doktori értekezés (Interspecific connections, correlations and the analysis of the ecological niche in oakwood species. Thesis for degree of D. Sc. in Hungarian). Bp. pp. 282 mscr.

Filzer, P. (1940): in ed. Marcelle, R. (1975): Environmental and Biological Control of Photosynthesis. Dr. W. Junk Publishers. The Hague, pp. 408.

Gessner, Fr. (1949): Chlorophyllgehalt im See und seine photosynthetische Valenz als geophysicalische Problem. Schweiz. Z. f. Hydrologie, II. 378—410.

Govindjee, ed. (1975): Bioenergetics of Photosynthesis. Acad. Press New York, San Francisco, London pp. 698.

Gorysina, T. K. (1969): Rannevesennie ephemeroidi lesostepni dubrav Izd. Leningradszkovo Unyiverszityeta, Leningrad, pp. 232.

Gorysina, T. K. (1975): Ekologiya travyanisti rasteniy lesostepnoi dubravi Izd. Leningrad. Univ., Leningrad pp. 127.

Jakucs, P. (1973): "Síkfőkút Project". Egy tölgyes ökoszisztéma környezetbiológiai kutatása a Bioszféra program keretén belül. (Environmental biological research into an oakwood ecosystems, within the framework of the biosphere Programme.) MTA Biol. Oszt. Közl. **16**, 1—25.

Majer, A. (1952): Az aljnövényzet szerepe bükköseink felújításában (Die Rolle des Unterwuchses in der Verjüngung des Waldes). Erd. Tud. Kis. Budapest, pp. 32.

Majer, A. (1976): Félévszázados kísérletek a farkasgyepüi bükkösökben (Half-century-old experiments in the beechwoods of Farkasgyepű). — (Monographs of HAS and VEAB.) MTA VEAB Monográfiái, **2**, Veszprém, pp. 236.

Maróti, I. (1976): Photosynthetical pigments in the spongy and palisade parenchymas and the alternative ways of photosynthesis. Acta Biol. Szeged. **22**, 7—14.

Nagy, L. (1976): A síkfőkúti cseres-tölgyes erdő 1975. évi rövidhullámú sugárzásgazdálkodása (Management in micro-wave radiation in 1975 of the turkey-oak forest of Síkfőkút). Debrecen, mscr.

Odum, E. P. (1971): Fundamentals of ecology. III. ed. Saunders Co. London pp. 574.

Odum, H. T.—McConnel, W.—Abbott, W. (1958): The chlorophyll A of communities. Publ. Inst. Marine Sc. 62—96.

Papp, M.—Jakucs, P. (1976): Phytozönologische Charakterisierung des Quercetum petraeae-cerris-Waldes des Forschungsgebiets "Síkfőkút Project" und seiner Umgebung. Acta Biol. Debrecina. **13**, 109—119.

RABINOWITCH, E.—GOVINDJEE, (1969): Photosynthesis J. Wiley and Sons, Inc. New York, London, Sydney, Toronto pp. 273.
ROSS, J. K. (1975): Radiacionni regim i architektonika rastitelnovo pokrova. Izd. Hidrometeoizdat. Leningrad, pp. 342.
TREBST, A.—AVRON, M. ed. (1977): Photosynthesis I. in Encyclopedia of Plant Physiology. Springer-Verlag Berlin Heidelberg New York pp. 730.
TUBA, Z. (1977): Examination of the vertical pigment structure in an oak forest. Acta Bot. Acad. Sci. Hung. **23,** 413—426.
WETTSTEIN, D. (1957): in SLYK, A. A. (1974): Chlorofill Izd. Nauka i Tyehnika, Minszk, pp. 416.
ZABOTINA, L. N. (1973): in GORYSINA (1975).
ŽELAWSKI, W.—SANIAWSKI, R.—DYBCZYNSKI, W.—PIECHUROWSKI, A. (1973): Photosynthetic Capacity of Conifers in Diffuse Light on High Illuminance. Photosynthetica. **7** (4) 351—357.
ŽELAWSKI, W.—WALKER, R. B. (1976): Photosynthesis, Respiration, and Dry Matter Production in MIKSCHE, J. P. (ed.) Modern Methods in Forest Genetics 89—119.
ZELLNIKER, J. L. ed. (1967): Svetovoi regim, fotosintes i produktivnosti lesa. Izd. Nauka, Moscow, pp. 275.
ZELLNIKER, J. L. (1968): Adaptaciya lesni rasteniy k zateneniu. Bot. Zhurn. **53,** 1478—1491.
ZELLNIKER, J. L. (1969): Radiacionniy regim pod pologom lesa. Izd. Nauka, Moscow, pp. 100.

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NEW ALGAE FROM HUNGARY

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The author examined the section of the Danube at Budapest, and the water producing systems of the Water Works of Budapest, from algological viewpoints between 1970 and 1976. In the present paper, he describes 26 taxa of the observed organs which are new for the science. Of them there are 8 nova species, 7 nova varietas, 11 nova forma. Also a new genus is described. Of the organs, 1 is *Cynophyta: Pelodictyon chlathratiforme* (Szafer) Geitler f. *maius* Hortob., 1 *Euglenophyta: Trachelomonas gregussii* Hortob. var. *danubialis* Hortob., 24 *Chlorophyta: Chlorogonium elongatum* Dang. var. *gigas* Hortob., *Pteromonas danubialis* Hortob., *Actinastrum ellipsoideum* Hortob., *A. hantzschii* Lagerh. var. *curvatum* Hortob., *Burkillia cornuta* W. et W. f. *minor* Hortob., *Chodatella cillata* (Lagerh.) Lemm. f. *crassa* Hortob., *Ch. quadrangularis* Hortob., *Ch. robusta* Hortob., *Crucigenia laxa* Hortob., *Didymocystis inermis* (Fott) Fott var. *danubialis* Hortob., *D. inermis* var. *danubialis* f. *simplex* Hortob., *Didymogenopsis* n. gen., *D. danubialis* Hortob., *Heleochloris conica* Korsch. f. *minor* Hortob., *Kirchneriella irregularis* (Smith) var. *danubialis* Hortob., *Lagerheimia genevensis* Chod. f. *crassiseta* Hortob., *L. genevensis* f. *granulata* Hortob., *L. genevensis* var. *spinosa* Hortob., *L. genevensis* var. *subglobosa* (Lemm.) Chod. f. *crassiseta* Hortob., *L. wratislawiensis* Schroed. f. *flexocaudata* Hortob., *Tetraëdron caudatum* (Corda) Hansg. var. *depaupereta* Printz. f. *granulatum* Hortob., *Tetrallantos gracilis* Hortob., *T. scenedesmoides* Hortob., *Tetrastrum heteracanthum* (Nordst.) Chod. var. *crassisetum* Hortob., *T. tenuispinum* Hortob. f. *irregulare* Hortob.

Diagnoses

1. **Pelodictyon clathratiforme** (Szafer) Geitler f. **maius** Hortob. **n. f.** Figs 1—2

Thallus filamentosus, forma varius, e filamentis variis modis curvatis laxe compositus. Cellulae ellipsoideae — quadratae. 1,4—6×1,3—2,6 μ, materiam homogeneam, pallide coeruleam, nonnunquam etiam vacuolum gasi continentes.

A specie typica cellulis maioribus (non 0,6—0,8 μ latis) distinctum. Puteus ad Surány, VI., X. 1971. — Raro.

2. **Trachelomonas gregussii** Hortob. var. **danubialis** Hortob. **n. var.** Fig. 3

Lorica ferruginea, 23,4—19 μ, poro 3 μ diam., superficie emergentiis rectis, inclinatis, punctiformibus obtecta.

A specie typica distinguitur: 1. collo absenti, 2. magnitudine
Danubius, 1674. fluv. chilom. X. 1972. — Rarissime.

3. **Chlorogonium elongatum** Dang. var. **gigas** Hortob. **n. var.**
Fig. 4.

Cellulae convexe fusoideae, 100—110×15—17 μ, membrana nonnunquam parum undulatae, parte postica cito tenuiescentes, acutataeque, parte antica similiter cito tenuiescentes, sed deinde tenuiter cylindricae, ante finem parum dilatatae et desectae; flagellis 2, cca. parte 1/4—1/3 longitudinis cellulae aequalibus, stigmate elongato, vacuolis pulsantibus 2, in plasmate corpusculis pluribus globosis et nonnullis baculiformibus. Chloroplastus magnus: partem 1/2 longitudinis cellulae efficiens, in medio cellulae dispositus, in eo nucleus conspicuus, ante et post hunc pyrenoidae singulae vel binae.

Danubius, 1630. fluv. chilom. IX. 1974. — Raro.

A specie typica magnitudine (non 20—45×4—7 μ, cf. Huber—Pestalozzi 1961. p. 470) distinctum.

4. **Pteromonas danubialis** Hortob. **n. sp.**
Fig. 5

Capsula hyalina, globosa, in medio partis superioris parum impressa, 23—26×24—26 μ, superficie 4 processibus bene evolutis, brevibus, quadrangulariter (quasi in extremis "angulis") singillatim dispositis, 4,5—6 μ longis ornata. Flagella 2, longitudine capsulae parum breviora. Chloroplastus magnus, in medio eius nucleus. Pyrenoidae 4, ordinarie dispositae. Vacuola pulsantia 2, prope polus superiorem disposita.

Danubius, 1630. fluv. chilom. IX. 1974. — Raro.

Pteromonas aculeata Lemm. ei proximus. Ab eo species nostra nova differt: 1. capsula globosa, 2. spinis (processibus) 4 alio modo dispositis, 3. spinis crassioribus.

5. **Actinastrum ellipsoideum** Hortob. **n. sp.**
Fig. 6

Coenobia plerumque 4-cellularia, e cellulis elongate ellipsoideis, in statu evoluto ante discessionem 9,7—10,4×4—4,5 μ magnis, polis late rotundatis constructa.

Danubius, 1669. fluv. chilom. V. 1972. — Raro.

A speciebus gen. *Actinastrum* cellulis habitu corporis brevibus, in polis ambobus ate rotundatis differt.

6. **Actinastrum hantzschii** Lagerh. var. **curvatum** Hortob. **n. var.**
Figs 7—9

Coenobia e cellulis paucis, 11—22×1,5—3,4 μ magnis, subtus late rotundatis, gradatim angustatis, apicibus elongatis, in clinatis, crassis atque obtusis constructa.

Danubius, 1669. fluv. chilom. V. 1972, V. 1974, 1628. fluv. chilom. 1603. fluv. chilom. V. 1976. — Raro.

A specie typica cellulis crassis obtusisque bene discrepat.

Actinastrum schroeteri var. *curvata* a HUBER-PESTALOZZI descripta propter cellulas inclinatas var. novae nostrae similis, sed polis cellularum mucronatis ab ea distincta. Apices cellularum var. crassapicatae similiter a HUBER-PESTALOZZI descriptae recti et nominis contrarie sat acuti.

7. **Burkillia cornuta** W. et W. f. **minor** Hortob. **n. f.**

Fig. 10

Thalli plerumque 16-cellulares, e cellulis quaternis, pyriformibus, 5—6×3—4,8 μ magnis, muco hyalino late circumdatis, chloroplastum parietalem et in eo pyrenoidam unicam, bene evolutam, conspicuam habentibus constructi.

A specie typica exiguitate (cellulae non 13—18 μ longae, cf. PHILIPOSE 1967. p. 235) distincta.

Danubius, VIII. 1971. — Valde raro.

8. **Chodatella ciliata** (Lagerh.) Lemm. f. **crassa** Hortob. **n. f.**

Fig. 11

Cellulae 14,2—12 μ a fronte visu paene tessellatae, angulis late rotundatae, in regione polorum spinis quinis, 10,5—12 μ longis, rectis vel parum inclinatis, tenuibus, mucronatis, pyrenoida conspicua et chloroplasto unico, cellulam implenti instructae.

Danubius, 1669. fluv. chilom. V. 1972. — Raro.

A specie typica statura compacta distincta.

9. **Chodatella quadrangularis** Hortob. **n. sp.**

Fig. 12

Cellulae angulis rotundatae, 6,5×5 μ magnae, spinis in regione polorum 2—3, in parte media 2, rectis vel vix inclinatis, mucronatis, 6—8 μ longis, chloroplasto unico cellulam implenti et pyrenoida unica conspicua in eo instructae.

Danubius, 1669. fluv. chilom. V. 1972. — Raro.

Nova species nostra forma eius *Chodatellae quadrisetae* Lemm. similis. Ab ea statura compactiore, spinis brevibus dispositioneque earum distincta.

10. **Chodatella robusta** Hortob. **n. sp.**

Figs 13—14

Cellulae ovales, cylindricae, 8—12×6—8,5 μ, lateribus convexae, polis late rotundatae, et in polis et in lateribus spinis singulis crassissimis, rectis vel inclinatis, obtusis, non semper levibus, fustiformibus, 14—22 μ longis, ad basin 1,2—1,5 μ latis, membrana levi et pyrenoida conspicua instructae.

Danubius, 1669. fluv. chilom. V. 1972. — Raro.

Chodatella budapestinensis Hortob. eae proxima. Ab ea spinis crassissimis, superficie non levibus, fustiformibus distincta.

11. **Crucigenia laxa** Hortob. **n. sp.**

Figs 15—16

Thalli 4-cellulares, e cellulis 4—8×2,9—4,2 μ magnis, laxe compositis, membrana levibus, forma variis, sed parte externa semper valde dilatatis, chloroplasto magno, parietali, cellulam implenti et paramylo unico magno, conspicuo instructis compositi.

Species haec nova per compositionem laxam formasque varias cellularum eximia.

Danubius, 1669. fluv. chilom. V. 1972. — Raro.

12. **Didymocystis inermis** (Fott) Fott var. **danubialis** Hortob. **n. var.**

Figs 17—18

Coenobia semper 2-cellularia, e cellulis muco hyalino cca. 2 μ crasso indutis, semiglobosis, parte superficiei magna sese attingentibus, 15—16×6—8 μ magnis, membranam hyalinam, papillis magnis satis remotis coopertam, in lateribus extrorsis costas binas verrucosas — papillatas, chloroplastum parietalem sed pyrenoidam non habentibus constructa.

A specie typica costis binis ex emergentiis dense dispositis formatis distincta.

Danubius, VIII. 1971. — Raro. — X. Non raro.

Genus *Didymocystis* coenobia 2-cellularia generis *Scenedesmi* in mentem revocat; secundum Fott (1973. p. 3) ab illis pyrenoidis absentibus differt.

13. **Didymocystis inermis** (Fott) Fott var. **danubialis** Hortob. f. **simplex** Hortob. **n. f.**

Figs 19—21

Coenobia semper 2-cellularia, e cellulis 6,5—15,6×3—8 μ magnis, paene semiglobosis, magna parte superficiei sese attingentibus, parte extrorsa membranae seriebus binis verrucarum magnarum ornatis, secus levibus, chloroplasto parietali cellulam paene implenti instructis formata.

A var. *danubiali* Hortob. membrana cellularum tantum seriebus binis verrucarum ornata (secus levi) distinctus.

Danubius, VIII. 1971. — Raro.

14. **Didymogenopsis Hortob.** n. gen.

Cellulae elongatae, corniculiformes, apicibus late rotundatae, binae, extrorsum deflectae, chloroplastum unicum, cellulam omnino vel paene omnino implentem, pyrenoidam conspicuem unicam continentem habentes. Multiplicatio per divisionem in duas partes.

Didymogenopsis danubialis Hortob. **n. sp.**
Fig. 22

Cellulae binae, extrorsum deflectae, 7,2—15,3×2,3—3 μ, membrana leves.

Danubius, 1634. fluv. chilom. VII. 1973. — Raro.

Didymogenes palatina Schmidle (*Chlorococcales*) ei simillima. Genus hoc novum et species nove per divisionem in duas partes ab ea distinctae.

15. **Heleochloris conica** Korsch. f. **minor** Hortob. **n. f.**
Fig. 23

Cellulae quaternae, in thallis ex cellulis pluribus compositis, 4—5,5×2,7—3,4 μ magnae, ovales vel ellipsoideae vel rotundato-trigonae, leves, in ipsis chloroplasto unico parietali et circa eas residuis visibilibus parietis cellulae maternae instructae.

A specie typica exiguitate (non 8,5—12,5×6,5—7 μ, cf. KORSCHIKOV 1953. p. 224) distincta.

Danubius, VIII. 1971. — Raro.

16. **Kirchneriella irregularis** (Smith) Korsch. var. **danubialis** Hortob. **n. var.**
Figs 24—26

Thalli e cellulis 4—8, variis modis curvatis, 8—12×1,3—2,3 μ magnis, apicibus semper distantibus, obtusis, versus apicem illis speciei typicae magis tenuiescentibus, chloroplasto unico repletis constructi.

Danubius, 1669. fluv. chilom. V. 1972. — Non raro.

Kirchneriella irregularis var. *spiralis* eae proxima. Var. nova ab ea distincta: 1. exiguitate, 2. cellulis conspicue gracilioribus, 3. spicibus cellularum distantioribus.

17. **Lagerheimia genevensis** Chod. f. **crassiseta** Hortob. **n. f.**
Figs 27—30

Cellulae 6—9×5—5,6 μ magnae, setis rectis vel inclinatis, crassis, 5,4—9,5 μ longis, apicibus obtusis, ad basin crassis, chloroplasto pyrenoidam unicam habenti instructae.

A specie spinis crassis, obtusis distincta.

Danubius, 1669. fluv. chilom. V. 1972. — Non raro.

Figurae nostrae 28—30 specimina enormia demonstrant: 2 specimina spinis amplius singulis, 1 autem spina una non existente, tantum per basin significata.

18. **Lagerheimia genevensis** Chod. f. **granulata** Hortob. **n. f.**
Fig. 31

Cellulae ovales, 8—10×4—5 μ, circa polos diagonaliter spinis binis, 8—10,5 μ longis, parum inclinatis, mucronatis, basi dilatatis, deinde membrana minute verrucosa, chloroplastis singulis, cellulam fere implentibus et pyrenoidas singulas habentibus instructae.

Danubius, 1669. fluv. chilom. V. 1972. — Raro.
A specie membrana verrucosa distincta.

19. **Lagerheimia genevensis** Chod. var. **spinosa** Hortob. **n. var.**
Fig. 32

Cellulae elongate ovales, 8—11×4—5 μ, circa polos spinis 4,4—6,3 μ longis, rectis vel parum inclinatis, deinde 1—3 spinulis 1—2,2 μ longis, membrana verruculis dense cooperta chloroplastisque singulis cellulam paene implentibus, pyrenoidas singulas bene evolutas habentibus instructae.

Danubius, 1669. fluv. chilom. V. 1972. — Raro.
A specie spinis pluribus, longitudine variis, deinde membrana verruculis cooperta distincta.

20. **Lagerheimia genevensis** Chod. var. **subglobosa** (Lemm.) Chod. f. **crassiseta** Hortob. **n. f.**
Fig. 33

Cellulae subglobosae, 7—9 μ diam., circa polos spinis brevibus, rectis vel inclinatis, crassis, obtusis, 3—3,4 μ longis, chloroplastis singulis cellulam implentibus, pyrenoidam magnam unicam habentibus instructae. Fig. 33: specimen cum quattuor autosporis.

Danubius, 1669. fluv. chilom. V. 1972. — Valde raro.

21. **Lagerheimia wratislawiensis** Schroed. f. **flexocaudata** Hortob. **n. f.**
Figs 34—38

Cellulae ellipsoideae, 9—12,6×5,2—8 μ, forte 2—8 autosporis, spinis crassis, mucronatis, semper undulatis, inclinatis, 10—27 μ longis, forma saepe insolitis, chloroplastis singulis parietalibus, cellulam paene implentibus, pyrenoidas singulas habentibus instructae.

A specie typica spinis crassis undulatis — inclinatis distincta.
Danubius, 1669. fluv. chilom. V. 1972. — Non raro.
Species typica quoque ad formationem spinarum prona: cf. FOTT 1928. tab. I. fig. d. Etiam *Lagerheimia wratislawiensis* Schroed. f. *heterospina* Hortob. saepe spinas undulatas vel inclinatas habet (HORTOBÁGYI 1966. p. 331, figs 1—14).

22. **Tetraëdron caudatum** (Corda) Hansg. var. **depauperata** Printz f. **granulatum** Hortob. **n. f.**
Fig. 39

Cellulae 9—10×10—11 μ, aspinosae, membrana granulis maioribus cooperta, chloroplastis singulis, pyrenoidam conspicuam, unicam habentibus instructae.

Danubius, 1638. fluv. chilom. VIII. 1974. — Raro.
A var. *depauperata* Printz membrana granulata distincta.

23. **Tetrallantos gracilis** Hortob. **n. sp.**
Fig. 40

Cellulae 10,5—14,5×1,3—1,5 μ, S-formiter curvatae, versus apices parum tenuiescentes, obtusae, in uno puncto inter sese coniunctae. Cellulae duae mediae caliciformiter dispositae, in parte infima inter sese coniunctae, cellulae duae extimae apice una ad medium cellularum mediarum applicatae. Chloroplastus parietalis paene totam cellulam implens, in eo pyrenoida una bene evoluta.

A *Tetrallanto lagaerheimii* Teiling cellulis gracilioribus et S-formiter curvatis, deinde dispositione cellularum distinctus.

Danubius, 1669. fluv. chilom. V. 1972. — Valde raro.

24. **Tetrallantos scenedesmoides** Hortob. **n. sp.**
Fig. 41

Cellulae binae, 6,5—8×2,3—2,6 μ, coenobia 4-, 8-vel 16-cellularia formantes, inclinatae, corniculiformes, apicibus obtusae, leves; cellulae ipsae et agmina ipsarum per mucum hyalinum cohaerentur, rarissime tantum immediate connecta, plerumque parum ab invicem remota. Cellulae binae ad invicem polis obtusis conversae, cellulis alteris geminatis tergis obversae. Chloroplastus parietalis, cellulam paene implens, in medio eius pyrenoida conspicua.

Danubius (brachium Soroksarense), VIII. 1972. — Raro.

Tetrallantos lagerheimii Teiling proximus. Ab eo species nova nostra distincta: 1. per cellulas binas in seriebus ordinatas. 2. per exiguitatem cellularum (non 14—24×5—8,5 μ cf. KORSCHIKOV 1953. p. 399; neque 10—24×3—8,5 μ cf. PHILIPOSE 1967. p. 291).

25. **Tetrastrum heteracanthum** (Nordst.) Chod. var. **crassispinum** Hortob. **n. var.**
Figs 42—43

Coenobia 4-cellularia, e cellulis 5—8 μ diam., cordiformibus, inter duas spinas emarginatis, spinis longis eximie crassis, 15,6—26 μ longis et spinis brevioribus, gracilibus, 4—5,5 μ longis, spinis omnibus rectis, apicibus mucronatis ornatis composita.

Fig. 43: coenobium irregulare: cellulae tantum duae spinis regulariter efformatae, una cellularum caeterarum duarum spina brevi, altera spina tantum longa, sed curvata instructa: cordiformitas in una cellula tantum conspicua.

Danubius, 1598. fluv. chilom. VIII. 1974. — Raro.

A specie cellulis cordiformibus et spinis longis crassissimis distinctum.

26. **Tetrastrum tenuispinum** Hortob. f. **irregulare** Hortob. **n. f.**
Figs 44—45

Cellulae 4—4,3 diam., spinis valde gracilibus, rectis, mucronatis, aliis singulis earum longioribus, 8,8—11,3 μ longis, plerumque secundum axem longitudinalem cellularum, aliis brevioribus, 5,5—7 μ longis, a longioribus parum distanter dispositis ornatae. Chloroplastus

parietalis, cellulam perfecte vel paene perfecte implens, in eo pyrenoida magna, conspicua. Fig. 44: in una cellula spinae 3, identicae illis speciei typicae: in hoc casu abnormitas, sed propinquitatem sine dubio demonstrans.

Danubius, 1598. fluv. chilom. VIII, IX. 1974, 1630. fluv. chilom. — Raro. — A specie una spinarum minore absenti cellularum distinguitur.

BIBLIOGRAPHIA

COMPÈRE, P. (1976): Observations taxonomiques et nomenclaturales sur quelques algues vertes (Chlorophyta) de la région du lac Tchad (Afrique Centrale). — Bull. Jard. Bot. Nat. Belg. Bull. Nat. Plantentuin Belg. **46,** 227—234.

FOTT, B. (1948): A monograph of the genera Lagerheimia and Chodatella. — Veštník Královské České Společnosti Nauk Třída Mat.-Přirod. **3,** 1—32.

FOTT, B. (1977): Taxonomische Übersicht der Gattung Actinastrum und der Unterfamilie Actinastroideae (Scenedesmaceae). — Preslia **49,** 1—8.

HORTOBÁGYI, T. (1966): Lagerheimia Convergencies in the Fishponds of Buzsák. — Acta Biol. Hung. **16,** Budapest, 327—339.

HORTOBÁGYI, T. (1967): Testrastrum-Arten aus den Fischteichen von Buzsák, Ungarn. — Rev. Roumaine de Biologie Ser. Bot. **12,** 41—46.

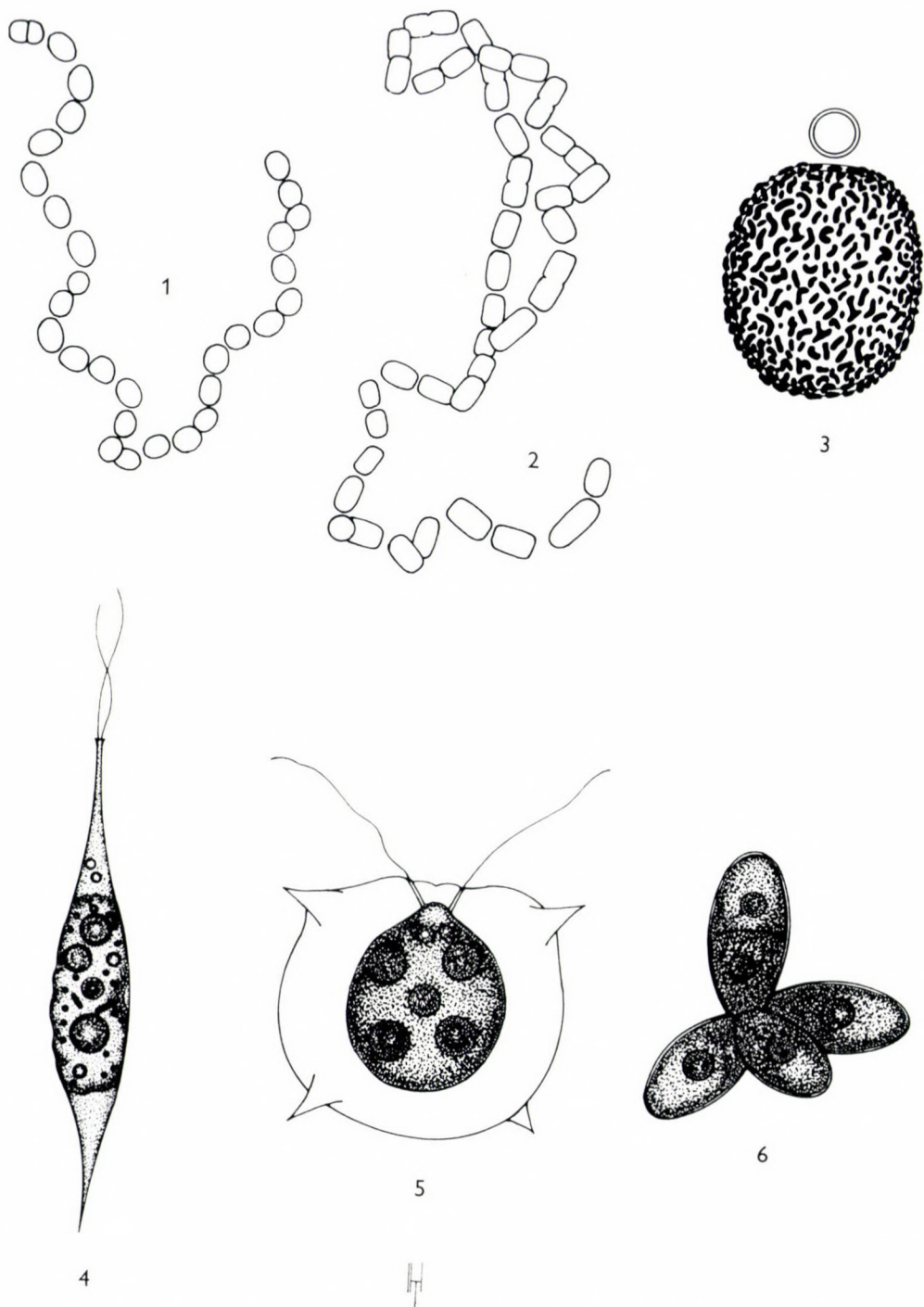
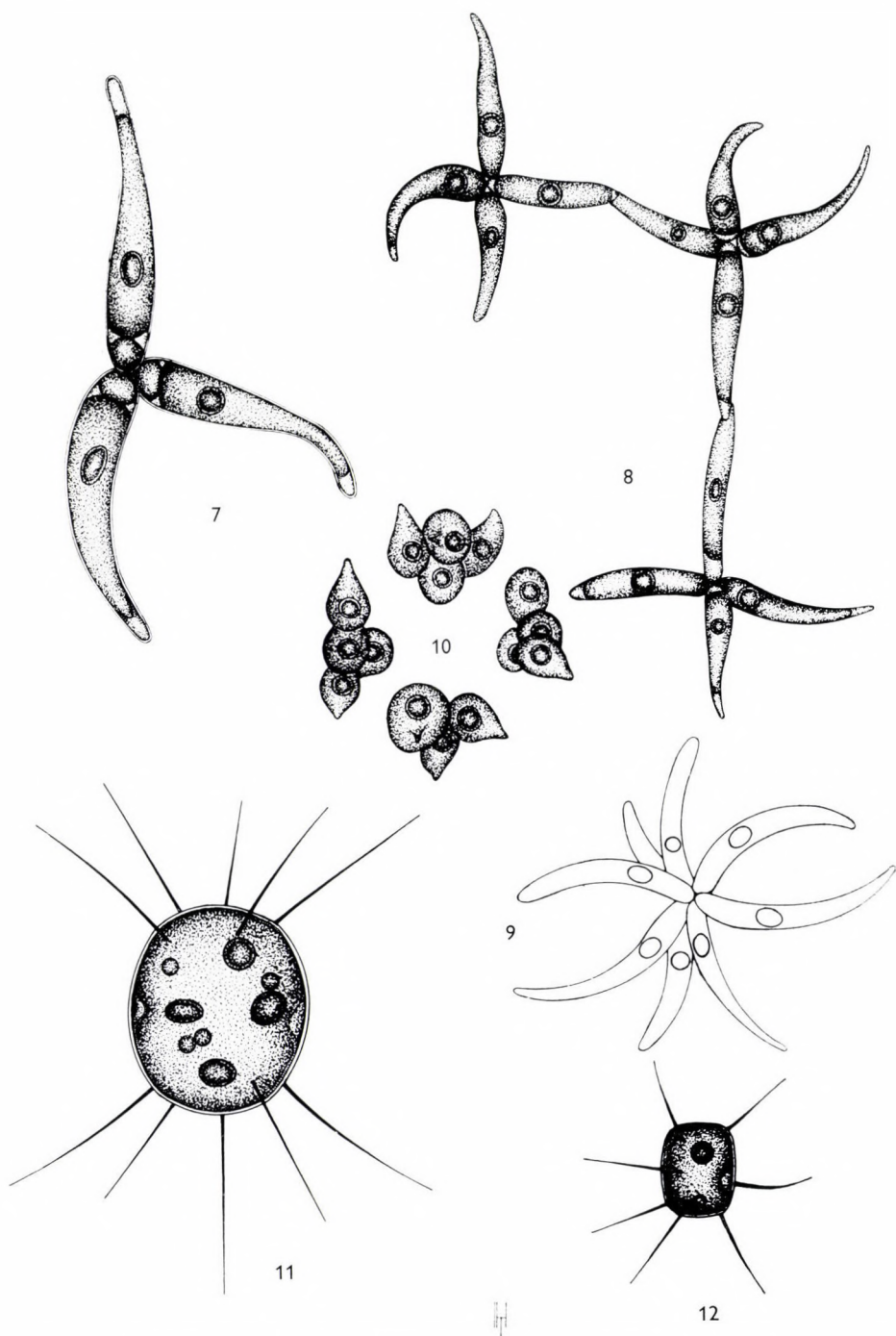
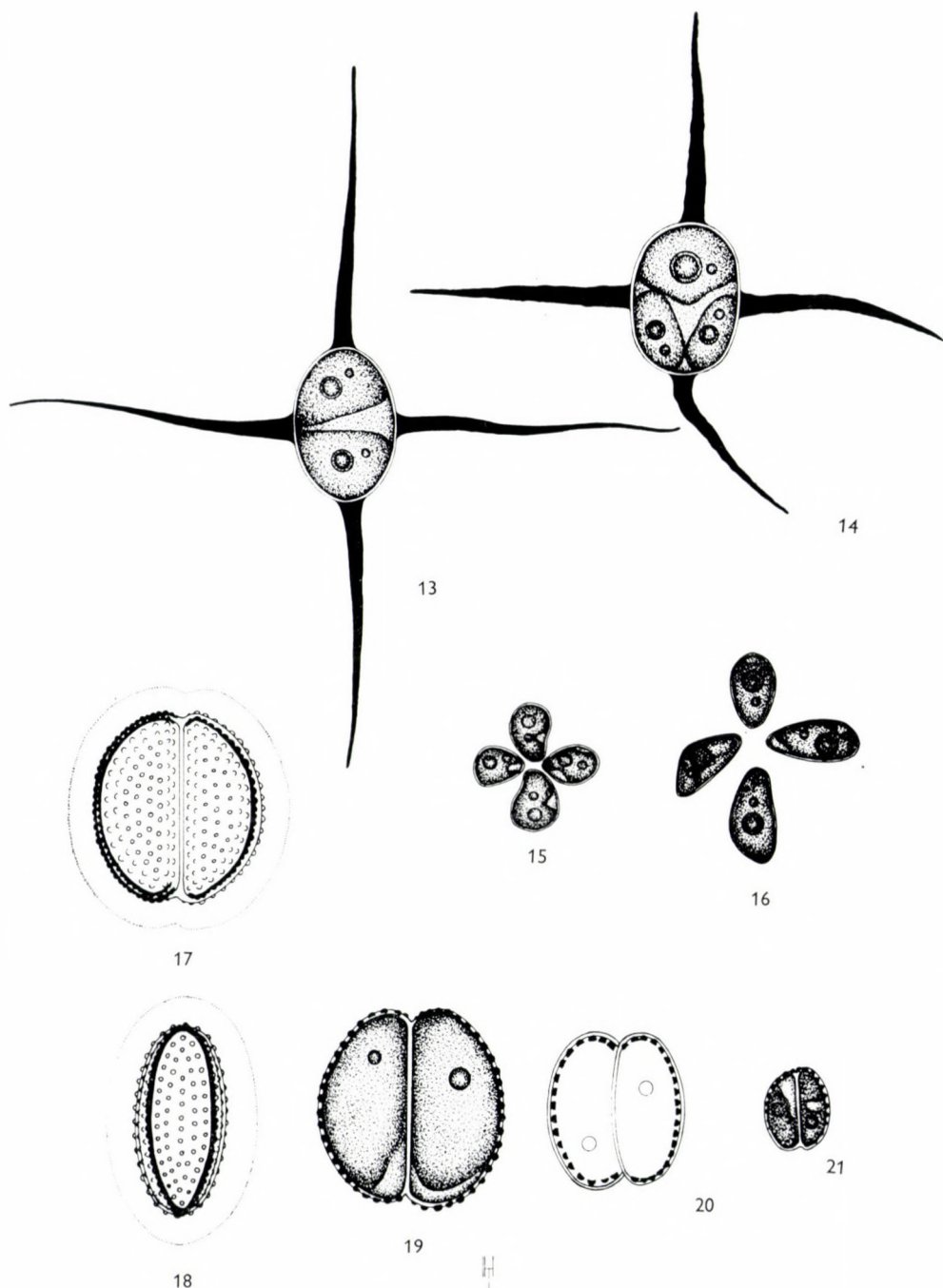
HUBER-PESTALOZZI, G. (1955): Euglenophyceen. — Das Phytoplankton des Süsswassers. Die Binnengewässer **16**/4, 1—606.

HUBER-PESTALOZZI, G. (1961): Volvocales. — Das Phytoplankton des Süsswassers. Die Binnengewässer **16**/5, 1—744.

KORSCHIKOV, O. A. (1953): Pidklasz Protokovi. — Viznacsnik Prisznovodnüh Vodorosztei Ukrainszkoi RSZR. **5,** 1—440.

KOVÁČIK, L. (1975): Taxonomic Rewiew of the Genus Tetraëdron (Chlorococcales). — Arch. Hydrobiol. Suppl. **46.** Algological Studies **13,** 354—391.

PHILIPOSE, M. T. (1967): Chlorococcales. — Indian Council of Agricultural Research, New Delhi, 1—365.

STARMACH, K. (1966): Cyanophyta — Glaucophyta. — Flora Słodkowodna Polski. **2,** 1—807

Figs. 1—2. Pelodictyon clathratiforme (Szafer) Geitler f. *major* Hortob.
Fig. 3. Trachelomonas gregussii Hortob. var. *danubialis* Hortob.
Fig. 4. Chlorogonium elongatum Dang. var. *gigas* Hortob.
Fig. 5. Pteromonas danubialis Hortob.
Fig. 6. Actinastrum ellipsoideum Hortob.

Figs. 7—9. Actinastrum hantzschii Lagerh. var. *curvatum* Hortob.
Fig. 10. Burkillia cornuta W. et W. f. *minor* Hortob.
Fig. 11. Chodatella ciliata (Lagerh.) Lemm. f. *crassa* Hortob.
Fig. 12. Chodatella quadrangularis Hortob.

Figs. 13—14. Chodatella robusta Hortob.
Figs. 15—16. Crucigenia laxa Hortob.
Figs. 17—18. Didymocystis inermis (Fott) Fott var. *danubialis* Hortob.
Figs. 19—21. Didymocystis inermis (Fott) Fott var. *danubialis* Hortob. f. *simplex* Hortob.

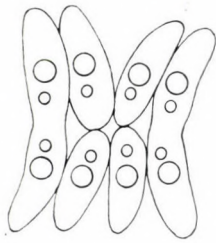
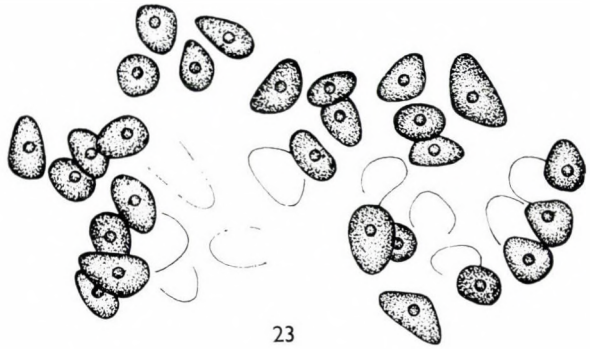
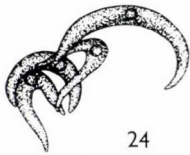
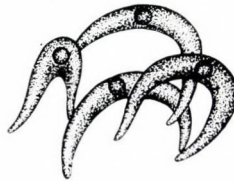
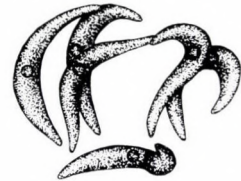
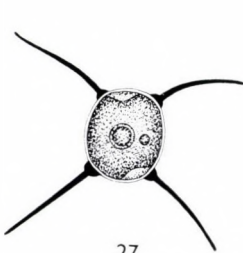
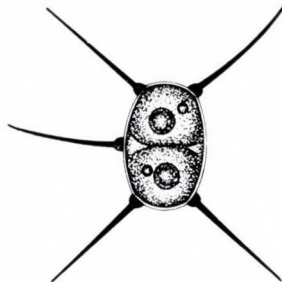
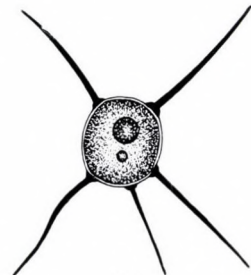
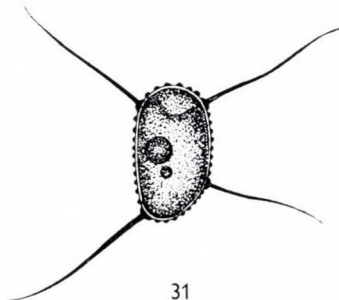
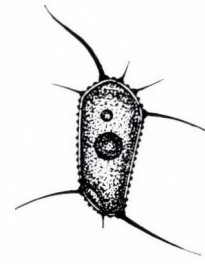



Fig. 22. Didymogenopsis danubialis Hortob.
Fig. 23. Heleochloris conica Korsch. f. *minor* Hortob.
Figs. 24—26. Kirchneriella irregularis (Smith) Korsch. var. *danubialis* Hortob.
Figs. 27—30. Lagerheimia genevensis Chod. f. *crassiseta* Hortob.
Fig. 31. Lagerheimia genevensis Chod. f. *granulata* Hortob.
Fig. 32. Lagerheimia genevensis Chod. var. *spinosa* Hortob.

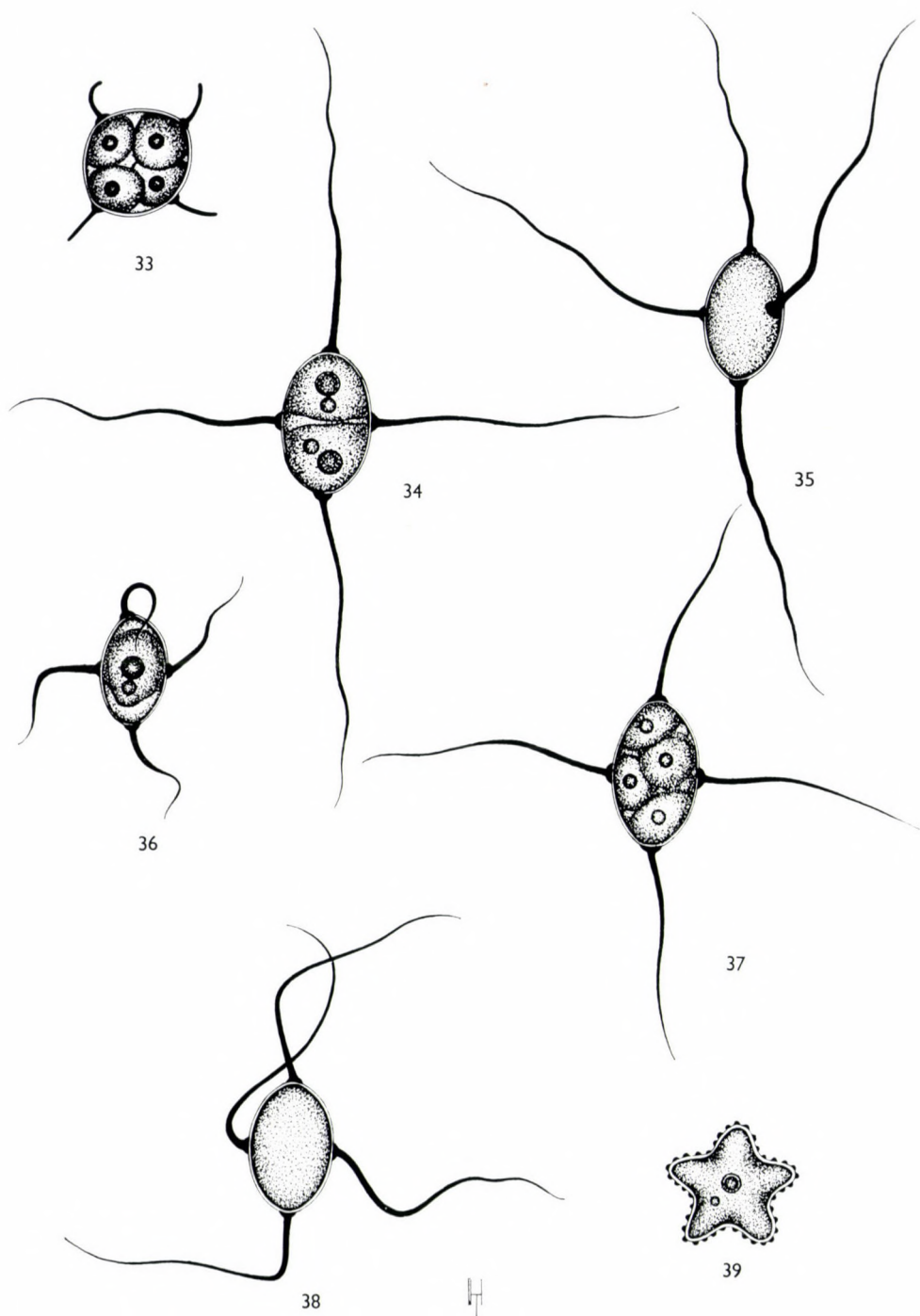



Fig. 33. Lagerheimia genevensis Chod. var. *subglobosa* (Lemm.) Chod. f. *crassiseta* Hortob.
Figs. 34—38. Lagerheimia wratislawiensis Schroed. f. *flexocaudata* Hortob.
Fig. 39. Tetraëdron caudatum (Corda) Hansg. var. *depauperata* Printz f. *granulatum* Hortob.

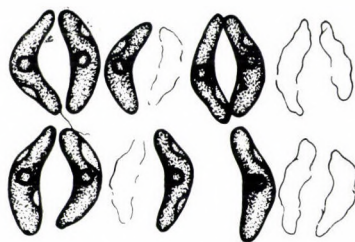
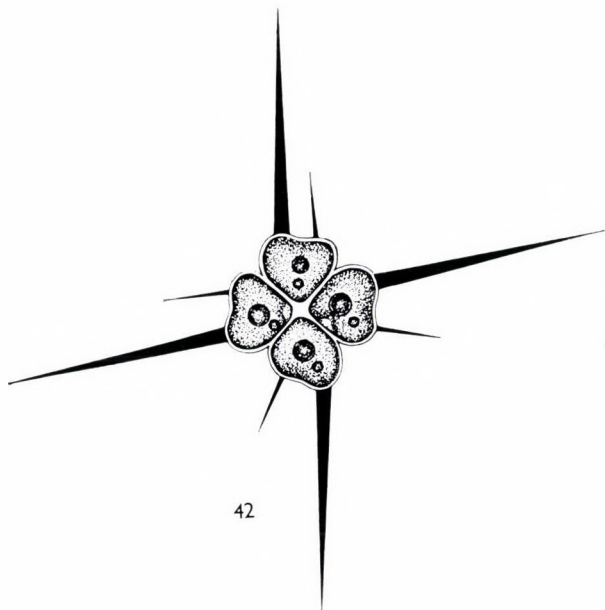
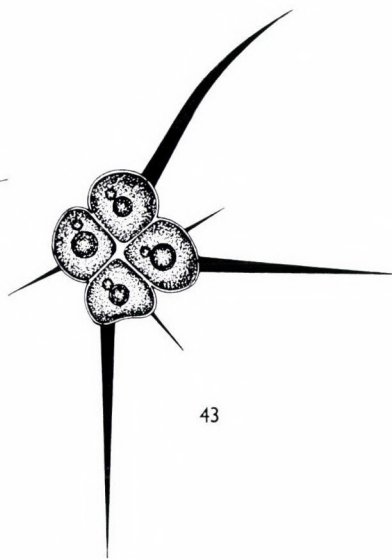
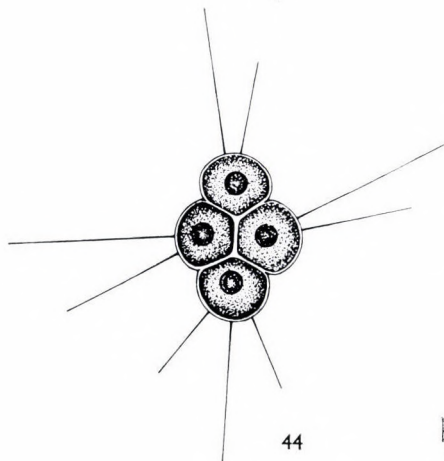
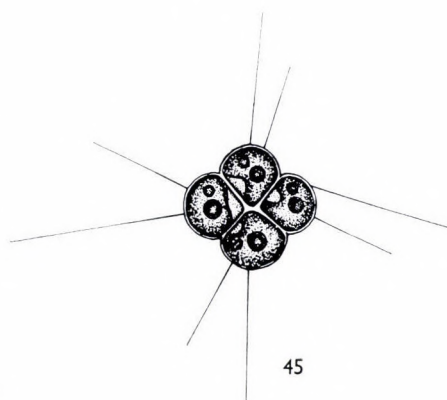



Fig. 40. Tetrallantos gracilis Hortob.
Fig. 41. Tetrallantos scenedesmoides Hortob.
Figs. 42—43. Tetrastrum heteracanthum (Nordst.) Chod. var. *crassispinum* Hortob.
Figs. 44—45. Tetrastrum tenuispinum Hortob. f. *irregulare* Hortob.

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SPATIAL PROCESSES IN A GRASSLAND COMMUNITY, I.

NUMBER OF SPECIES AND INDIVIDUALS, COVER AND BIOMASS AT THE COMMUNITY LEVEL*

By

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The changes of some characteristics of vegetation (number of species, number of individuals, cover, biomass) were studied as the function of the area (five different plot sizes, from 0.04 m^2 to 1.0 m^2) in different seasonal aspects in a sandy grassland community. The sampling was carried out by independent quadrats randomly located.

The values of the number of species and individuals reflected the seasonal aspects of the community well. They were the lowest in summer (cf. only the species adapted to the semi-arid conditions were present). The cover did not show a systematic change with the aspects. The quantity of living fitomass increased from spring till autumn. All parameters reached their maximum in autumn (except dead fitomass).

In every season the number of species showed a logarithmic relation to the area. There were positive linear relationships between the other characteristics and the area. The percentage difference between the measured and calculated values were established for the unit of 1.0 m^2.

Comparising the seasonal changes and the changes in the function of the area the slightest and steepest slopes were established in the season when the different variables showing a systematic change with the aspects reached their minimal and/or maximal values.

Positive linear correlations were found between the various pairs of the characteristics investigated. There were seasonal differences in the slopes of the curves.

Introduction

Several articles have dealt with the application of sample units of different size and shape in vegetation studies. The aim of the majority of the investigations was to establish the optimal size and shape referred to the different parameters (e.g. herbage production, frequency, number of species . . .). Depending on the aim of the studies random or contiguous quadrats were applied. But to make a statistical analysis (e.g. calculation of S.E.) we must use random sampling (FISHER 1958; FINNEY 1962; JOLLY 1957; SAMPFORD 1962). As "... the major drawback of systematic sampling is that it does not offer in itself the basis for the assessment of error" (BOURDEAU 1953).

The contiguous quadrats have been used in the pattern analysis to study the structure of plant communities (GREIG-SMITH 1952, 1964; KERSHAW 1963, 1970; USHER 1969).

Although the use of contiguous quadrats for sampling of the quantitative characteristics of vegetation is objectionable, they have been applied in many cases, e.g. WIEGERT (1962) used nested quadrats to determine the optimal quadrat size for sampling of standing crop.

* "Tece studies" No. 17.

RICE (1969) suggested a procedure to determine the proper quadrat size and the sufficient number of replications of this size. For this reason he applied nests of quadrats and estimated the distribution of plant material on the basis of the areal cover %. PRÉCSÉNYI and MÁTHÉ (1969) "... examined how the form and size of plots has influenced the estimation of the plant mass". They used a network system of contiguous quadrats. They emphasized that the estimation of error variance is dubious in a such design. The methodological character of the study and the technical difficulties in field work gave reason for use of the network system. GOLLEY (1965) published conversion factors from 1/4 m² to 1 m² basis for average biomass of different plant parts. To determine the conversion factors he used quadrats of 1/4 and 1 m² putting the small quadrats to the center of the large ones. In general the samplings of the quantitative characteristics of vegetation in the above mentioned and other investigations were carried out by means of nested and/or contiguous quadrats.

VAN DYNE et al. (1963) used random samples to investigate the "influence of small plot size and shape on range herbage production estimates". They applied four shapes, three of them had two different sizes. There were five replications of each size and shape combination. Beside this rectangular plots consisting of contiguous quadrats were randomly located, too.

We know very little about the changes of quantitative characteristics of vegetation in space. In this interpretation spatial process means the behavior in the function of sampling unit size (c.f. DÉVAI, HORVÁTH and JUHÁSZ-NAGY 1971; FEKETE and SZŐCS 1974).

The aim of the study

Our study was designed to determine the changes of some parameters (number of individuals, number of species, biomass, cover) as a function of the area in different seasonal aspects using independent quadrats. The investigation of the above mentioned parameters was extended both to the whole community and to the populations of the separate species.

Material and methods

Investigations were carried out in a sandy grassland community (*Festucetum vaginatae danubiale*) near Vácrátót (North-Hungary) in 1977. A detailed description of this area can be found in the papers KÁRPÁTI I. and KÁRPÁTI V. (1954), FEKETE et al. (1976).

Sampling was performed in different seasonal aspects of the community, on May 10—11th, July 12—13th and September 27—28th. In each occasion we used five plots of different sizes (0.04, 0.16, 0.36, 0.64 and 1.0 m²), each of three replications. Samples were randomly located. Number of species and individuals were recorded in situ in the field. Photographs were taken of each plot. After this the plant material was clipped at the ground surface and gathered. On the basis of the photographs maps of a scale 1 : 2 were drawn (Fig. 1). On these maps the separate specimens were represented by the accurate perpendicular projection of their aerial parts. Cover values of the individuals were measured by planimeter. Two different kinds of cover were used:

a) the sum of species cover (overlaps were taken into consideration at every overlapping specimens), mentioned further as "total cover";

b) the "commonly used" cover (overlaps were taken into consideration at only one of the overlapping specimens), mentioned further "visual cover".

The harvested plant material was separated into dead and living plant parts. The latter one was separated further into species. The dead fraction contains the litter collected from the ground surface, too.

15 plant species were found in the quadrats during the sampling period: *Festuca vaginata*, *Fumana procumbens*, *Thymus* sp., *Carex stenophylla*, *Cynodon dactylon*, *Centaurea arena-*
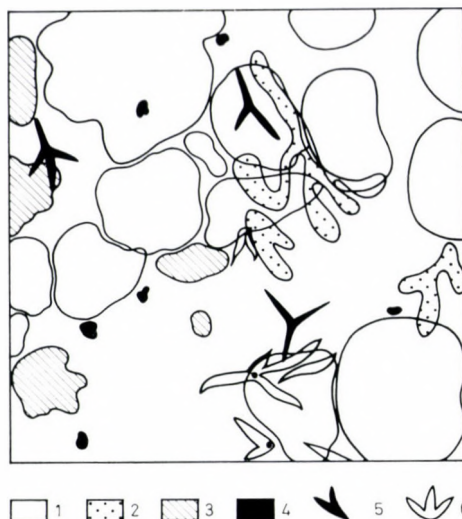
Fig. 1. A detail from the map of the vernal aspect. 1. *Festuca vaginata*, 2. *Fumana procumbens*, 3. *Thymus* sp., 4. *Arenaria serpyllifolia*, 5. *Carex stenophylla*, 6. *Cynodon dactylon*

ria, Medicago minima, Arenaria serpyllifolia, Polygonum Kitaibelianum, Kochia laniflora, Minuartia verna, Myosotis arvensis, Erigeron canadensis, Euphorbia seguieriana, Bromus squarrosus, and the moss *Syntrychia ruralis.*

The following uniform designations and symbols are used: $\bar{S}$ — number of species, $\bar{N}_T$ — total number of individuals $\left(\bar{N}_T = \sum_{i=1}^{S} N_i\right)$, $\bar{C}_T$ — total cover without moss $\left(\bar{C}_T = \sum_{i=1}^{S} C_i\right)$, $\bar{C}_V$ — visual cover without moss, $\bar{C}_{V+M}$ — visual cover including moss, $\bar{B}_{LT}$ — total living fitomass $\left(\bar{B}_{LT} = \sum_{i=1}^{S} B_{Li}\right)$, $\bar{B}_D$ — total dead fitomass and A — the area of the quadrat.

The dash above the various symbols represents the mean of the three replications. In some cases a greater sample size was needed, therefore we repeated the sampling on the basis of the maps. On the maps of each plot size we put randomly one quadrat of the smaller sizes each (e.g. on the 1.0 m² size the plots of 0.04, 0.16, 0.36 and 0.64 m²; on the 0.64 m² size the plots of 0.04, 0.16 and 0.36 m² etc.). In this way we got the following replications: 15, 12, 9, 6 and 3 for the plot sizes from the smallest to the greatest, respectively. The mean of these replications is indicated by dash-star ($^{-*}$) above the separate symbols.

The test of linearity was made according to WAINRIGHT and GILBERT (1977).

Results and discussion

1. Seasonal changes

1.1. The average species number ($\bar{S}$) indicates the seasonal aspects in the community (Fig. 2). Its value was the lowest in summer. At this time only the species could be found that tolerated the semiarid conditions. In our investigations they were: *Festuca vaginata, Fumana procumbens, Thymus* sp., *Carex stenophylla.* These species were also the most abundant. $\bar{S}$ in spring and autumn was about of the same value, but higher than that of in summer.
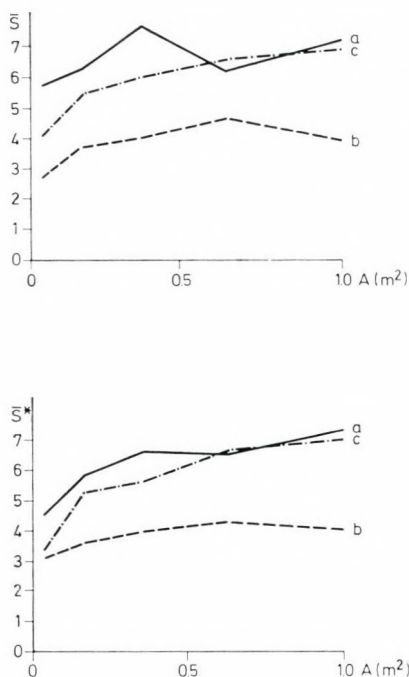
Fig. 2. $\bar{S}$ and $\bar{S}^*$ plotted against the plot size. a: spring, b: summer, c: autumn

It is due to the presence of species characteristic of the spring and/or autumn aspects (e.g. *Arenaria serpyllifolia, Myosotis arvensis*; *Medicago minima, Polygonum Kitaibelianum, Kochia laniflora,* etc.).

1.2. The average total number of individuals ($\bar{N}_T$) also varied in the aspects (Table 1). N_T was the lowest in summer — similarly to the $\bar{S}$ —, and the highest in autumn at all plot sizes. The low summer values are due to the disappearance of the vernal species. It was remarkable in autumn the large number of *Medicago* seedlings forming about 40—80% of the total number of individuals, and causing at the same time the high $\bar{N}_T$.

1.3. A systematic relation could not be detected with the aspects in the case of the "total" and "visual" cover at all plot sizes (Table 1). The values of both cover types decreased to summer in the plots of 0.04, 0.16, 0.36 m^2, but increased in the plots of 0.64, 1.0 m^2. The highest values were reached at all plot sizes in autumn owing to the species shooting in the autumnal aspect. Adding the moss cover to the "visual" cover the value of the latter one was increased slightly, but not significantly. The percentual values changed in the same manner.

1.4. The quantity of living fitomass increased from spring till autumn almost at all plot sizes (Table 1). The decreasing $\bar{N}_T$ was not reflected in the total living fitomass in summer. The increase in weight caused by the growth

Table 1

The values of the different variables as a function of the plot size

A (m^2)	0.04	0.16	0.36	0.64	1.0
$\bar{N}_T$ (ind.)	25.33	45.67	100.33	185.67	275.67
	13.33	35.33	89.33	172.33	243.00
	32.00	139.33	217.67	277.33	389.00
$\bar{C}_T$ (cm^2) (%)	213.6	887.0	1739.0	3093.0	4169.0
	53.4	55.4	48.3	48.3	41.7
	167.2	587.2	1284.6	3641.0	6506.0
	41.8	36.7	35.7	56.9	65.1
	299.7	1175.2	3358.2	4804.6	8795.0
	75.0	73.5	93.3	75.1	87.9
$\bar{C}_V$ (cm^2) (%)	210.3	798.4	1623.5	2976.7	4044.0
	52.6	50.0	45.1	46.5	40.0
	156.3	557.3	1236.6	3322.4	5856.0
	39.0	34.8	34.4	51.9	58.6
	268.2	1067.0	2782.0	3967.0	7267.0
	67.0	66.7	77.3	62.0	72.7
$\bar{C}_{V+M}$ (cm^2) (%)	225.7	1018.3	1649.0	3353.0	4281.0
	56.4	63.6	45.8	52.4	42.8
	164.3	571.3	1259.5	3445.6	6043.2
	41.1	36.7	34.9	53.8	60.4
	273.1	1098.0	2797.0	4040.0	7495.0
	68.3	68.6	77.7	63.1	74.9
$\bar{B}_{LT}$ (g)	3.18	9.90	30.65	38.52	62.30
	4.18	11.04	26.19	45.41	74.95
	4.32	18.04	30.37	53.48	96.74
$\bar{B}_D$ (g)	6.43	23.00	53.88	85.45	176.48
	7.62	28.34	40.83	106.54	163.63
	6.94	30.13	46.76	96.38	143.40

(The three values below one another at a given variable and area correspond to the seasons spring, summer and autumn.)

of the species adapted to the semi-arid period and/or the earing Festuca species exceeded the loss in weight of the absent vernal species. The higher $\bar{B}_{LT}$ values in autumn have the similar explanation as the cover. The dead fitomass did not show systematic changes.

The three dominant species — *Festuca vaginata, Fumana procumbens, Thymus* sp. — formed the majority of the "total" and "visual" cover and/or the living fitomass in all cases.

2. Changes in the function of the area

2.1. A logarithmic relation was found between the area and $\bar{S}$ in the case of summer and autumn aspects. The use of $\bar{S}^*$ despite of S in the calculations resulted the same relationship in the spring, too. Considering the slopes of the regression curves $\bar{S}^*$ increased most rapidly in autumn and in the slightest degree in summer (Fig. 2, Table 2).

Table 2

The correlation and linear regression coefficients between the area (x variable) and the different variables (y variable)

	Spring		
	r	a	b
$\bar{S}$	0.7097	3.061	1.049
$\bar{S}^*$	0.9119*	0.360	1.661*
$\bar{N}_T$	0.9986***	8.474	268.30***
$\bar{C}_T$	0.9945***	196.607	4144.9***
$\bar{C}_V$	0.9954***	149.383	4048.2***
$\bar{C}_{V+M}$	0.9885**	222.579	4279.1**
$\bar{B}_{LT}$	0.9873**	2.371	60.32**
$\bar{B}_D$	0.9863**	−6.392	171.45**

	Summer		
	r	a	b
$\bar{S}$	0.8883*	−0.231	1.174*
$\bar{S}^*$	0.9212**	1.219	0.758**
$\bar{N}_T$	0.9969***	1.715	247.60***
$\bar{C}_T$	0.9880**	−531.626	6747.6**
$\bar{C}_V$	0.9899**	−440.712	6060.1**
$\bar{C}_{V+M}$	0.9896**	−458.270	6261.5**
$\bar{B}_{LT}$	0.9990***	−0.142	73.86***
$\bar{B}_D$	0.9909**	−3.176	164.93**

	Autumn		
	r	a	b
$\bar{S}$	0.9991***	−1.618	2.160***
$\bar{S}^*$	0.9924***	−3.026	2.512***
$\bar{N}_T$	0.9744**	61.007	341.00**
$\bar{C}_T$	0.9935***	−113.848	8637.2***
$\bar{C}_V$	0.9934***	−43.231	7076.1***
$\bar{C}_{V+M}$	0.9931***	−68.762	7294.1***
$\bar{B}_{LT}$	0.9933***	−0.336	93.02***
$\bar{B}_D$	0.9966***	2.493	141.43***

Levels of significance: * = 5%, ** = 1%, *** = 0.1%.
(In the case of $\bar{S}$ and $\bar{S}^*$ the logarithm of the area was used as x variable.)

2.2. A positive linear relation exists between $\overline{N}_T$ and A in every aspect. Increasing the area the changes of $\overline{N}_T$ in the various aspects was similar to that of the $\overline{S}^*$. The identification of one "individual" at "patch-forming" species (like *Festuca, Fumana, Thymus*) is more or less arbitrary. In our investigations we considered one patch to one individual. The high correlation coefficients ($\overline{N}_T$ — A) indicate that this assumption is not false (Table 2). The linear correlation has been found to be valid to 48 m^2 in another investigation in the same community using this assumption (NOSEK 1976).

2.3. The values of $\overline{C}_T$ and $\overline{C}_V$ behaved similarly to each other and also showed a positive linear relation to A (Table 2). The slopes of the curves became more and more steeper from spring till autumn. Including the cover of moss into the $\overline{C}_V$ ($\overline{C}_{V+M}$) the character of the curves did not change only their slopes increased slightly.

2.4. In the case of the fitomass a positive linear relation could be also established. The slopes of curves calculated from the living fitomass changed similarly to that of the cover values. Considering a given amount of living fitomass it was produced on a smaller and smaller area from spring till autumn. The dead fitomass showed a reverse behaviour (Table 2).

2.5. The values of the different variables can be calculated for the unit of 1 m^2 on the basis of the regression curves. The percentage difference between the measured and calculated values are given in the Table 3.

Table 3

The percentage difference between the measured and calculated values of the different variables at 1 m^2

	$\overline{S}$	$\overline{S}^*$	$\overline{N}_T$	$\overline{C}_T$	$\overline{C}_V$	$\overline{C}_{V+M}$	$\overline{B}_{LT}$	$\overline{B}_D$
Spring	−1.0	−4.4	0.5	4.1	3.8	10.5	0.6	−6.5
Summer	12.0	6.25	2.5	−4.4	−4.0	−3.9	−1.6	−1.1
Autumn	0.3	0.3	3.3	−3.1	−3.2	−3.6	−4.2	0.3

(Negative values represent underestimations of the measured values, positive values are overestimations.)

2.6. Making a comparison between the seasonal changes and the changes in the function of the area the slightest and the steepest slopes were established in the season when the different variables showing a systematic change with the aspects reached their minimal and/or maximal values. The increase per unit of area was the most intensive for all variables (except $\overline{B}_D$) in autumn. The slightest increase was given for S*, $\overline{N}_T$ in summer, for $\overline{C}_T$, $\overline{C}_V$, $\overline{C}_{V+M}$, and $\overline{B}_{LT}$ in spring, for $\overline{B}_D$ in autumn (cf. Tables 1 and 2).

3. The relation between the separate variables

A correlation and linear regression analysis was made between the different variables ($\overline{C}_V$ — $\overline{C}_T$; $\overline{C}_T$ — $\overline{B}_{LT}$; $\overline{N}_T$ — $\overline{B}_{LT}$, $\overline{N}_T$ — $\overline{C}_T$; $\overline{B}_{LT}$ — $\overline{B}_D$). The first member of each pair was considered as the X variable. A positive linear correlation was found in all cases (Table 4).

Table 4

The correlation and linear regression coefficients between the different variables

X	Y	Spring		
		r	a	b
$\overline{C}_V$	$\overline{C}_T$	0.9995***	26.43	1.033***
$\overline{C}_T$	$\overline{B}_{LT}$	0.9634***	−0.16	0.0144***
$\overline{N}_T$	$\overline{C}_T$	0.8541***	224.57	14.192***
$\overline{N}_T$	$\overline{B}_{LT}$	0.8459***	2.353	0.2099***
$\overline{B}_{LT}$	$\overline{B}_D$	0.9084***	1.181	2.347***

X	Y	Summer		
		r	a	b
$\overline{C}_V$	$\overline{C}_T$	0.9995***	−32.56	1.110***
$\overline{C}_T$	$\overline{B}_{LT}$	0.9830***	6.66	0.0105***
$\overline{N}_T$	$\overline{C}_T$	0.8570***	−21.57	22.219***
$\overline{N}_T$	$\overline{B}_{LT}$	0.9002***	4.654	0.2503***
$\overline{B}_{LT}$	$\overline{B}_D$	0.9671***	−1.086	2.178***

X	Y	Autumn		
		r	a	b
$\overline{C}_V$	$\overline{C}_T$	0.9989***	−56.38	1.215***
$\overline{C}_T$	$\overline{B}_{LT}$	0.9435***	1.56	0.0106***
$\overline{N}_T$	$\overline{C}_T$	0.8778***	−691.43	20.693***
$\overline{N}_T$	$\overline{B}_{LT}$	0.8162***	−5.343	0.2173***
$\overline{B}_{LT}$	$\overline{B}_D$	0.9425***	7.893	1.399***

Level of significance: *** = 0.1%.

The correlation coefficients between $\overline{C}_V$ and $\overline{C}_T$ were very high, and there were no differences among the three aspects. The little differences in the slopes may be due to the fact that the degree of overlap among the specimens increases from spring till autumn.

A strong correlation was found between the "total" cover and the total living fitomass. The possibile explanation of the lower slopes of the summer and autumn curves is that the ratio of the living (green) and dead parts is smaller in summer and autumn than in spring. (Measuring the cover on the maps the standing, but already dead parts could not be separated from the living parts. In the case of the biomass, however, they were added to the dead parts.)

$\bar{N}_T$ showed a weeker correlation with $\bar{C}_T$ and/or B_{LT} than the former pairs. In the community there are present the seedlings of annual and perennial species and the older individuals of perennial species at the same time. The specimens of different ages have different cover and biomass.

Studying the relationship between the $\bar{B}_{LT}$ and $\bar{B}_D$, it can be established that a given amount of $\bar{B}_D$ belongs to greater and greater amount of $\bar{B}_{LT}$ from spring till autumn. The $\bar{B}_D/\bar{B}_{LT}$ value is the highest in spring because of the litter of the previous year. This ratio decreases till autumn in consequence of the decomposition and/or the increase of $\bar{B}_{LT}$.

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REFERENCES

BOURDEAU, Ph. F. (1953): A test of random versus systematic ecological sampling. Ecology, **34,** 499—512.

BROWN, D. (1954): Methods of surveying and measuring vegetation. Commonw. Bur. Past. Fld. Crops. Bull. **42.** — C.A.B. Farnham Royal.

DÉVAI, I.—HORVÁTH, K.—JUHÁSZ-NAGY, P. (1971): Some problems of model-building in synbiology. Part 1. Spatial diversity process of the binary type in a simple situation. Annal. Univ. Sci. Budap., Sect. Biol. **13,** 19—32.

FEKETE, G.—PRÉCSÉNYI, I.—MOLNÁR, E.—MELKÓ, E. (1976): Niche studies on some plant species of a grassland community I. Comparison of various measurements. Acta Bot. Acad. Sci. Hung. **22,** 321—354.

FEKETE, G.—SZŐCS, Z. (1974): Studies on interspecific association processes in space. Acta Bot. Acad. Sci. Hung. **20,** 227—241.

FINNEY, D. J. (1962): An introduction to statistical science in agriculture. Munksgaard, Copenhagen.

FISHER, R. A. (1958): Statistical methods for research workers. 13th Ed. Oliver et Boyd, Edinburgh.

GOLLEY, F. B. (1965): Structure and function of an old-field broomsedge community. Ecol. Monogr. **35,** 113—138.

GREIG-SMITH, P. (1952): The use of random and contiguous quadrats in the study of the structure of plant communities. Ann. Bot. **16,** 293—316.

GREIG-SMITH, P. (1964): Quantative plant ecology. 2nd Ed. London.

JOLLY, Cr. M. (1959): Theory of sampling. In: BROWN, D.: Methods of surveying and measuring vegetation. 2nd Ed. C.A.B. Bull. No. **42,** 8—18.

KÁRPÁTI, I.—KÁRPÁTI, V. (1954): The aspects of the calciphilous turf (Festucetum vaginatae danubiale) in the environs of Vácrátót in 1952. Acta Bot. Acad. Sci. Hung. **1,** 129—157.

KERSHAW, K. A. (1963): Pattern in vegetation and its causality. Ecology, **44,** 377—388.

KERSHAW, K. A. (1970): An empirical approach to the estimation of pattern intensity from density and cover data. Ecology, **51,** 729—734.

NOSEK, J. N. (1976): Comparative analysis of some diversity functions under different conditions of sampling in sandy meadow. Acta Bot. Acad. Sci. Hung. **22,** 415—436.

PRÉCSÉNYI, I.—MÁTHÉ, I. (1969): Szárazföldi növényi biomassza becslésének néhány mintavételi kérdése. Bot. Közlem. **56,** 37—42.

RICE, E. L. (1967): A statistical method for determining quadrat size and adequacy of sampling. Ecology **48,** 1047—1049.

SAMPFORD, M. R. (1962): An introduction to sampling theory with applications to agriculture. Oliver et Boyd, Edinburgh.

USHER, M. B. (1969): The relation between mean square and block size in the analysis of similar patterns. J. Ecol. **57,** 505—514.

VAN DYNE, G. M.—VOGEL, W. G.—FISSER, H. G. (1963): Influence of small plot size and shape on range herbage production estimates. Ecology, **44,** 743—759.

WAINWRIGHT, S. J.—GILBERT, R. I. (1977): Data which illustrate an important use of the analysis of covariance. J. Biol. Educ. **11,** 266—268.

WIEGERT, R. G. (1962): The selection of an optimum quadrat size for sampling the standing crop of grasses and forbs. Ecology **43,** 125—129.

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DATA ON THE REPRODUCTION CAPACITY OF QUERCUS CERRIS L.*

By

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The paper contains data related to the reproduction capacity of *Quercus cerris* L. measured under natural conditions (in years between 1977 and 1978).

In a forest part of 6 ha, under 50 sample trees, in permanent quadrata of 1 m², we examined the number of acorns fallen on the ground, and also that of the seedlings developed from them, which were still living after one year had passed.

It has been stated that the reproductive capacity, $C_r = 19.1\%$; this corresponds to a value of $\overline{C}_r = 17.86$ place/m²/10 months. The mortality of the seedlings, $M = 44.88\%$, while the general mortality, $\overline{M} = 14.54$ piece/m²/4 months.

By the time it reached the ground a considerable part of the fruits (46.3%) had already been damaged. A great quantity of the acorn (47.8%) was consumed by big games and rodents. Of the fruits that started to grow, 73% fell unripe, undeveloped. The interactions influencing the reproductive capacity are presented in a separate figure.

Introduction

Under natural conditions, our forest trees reproduce themselves mainly by their seeds and fruits. Reproduction by seeds has acquired considerable role also in the areas drawn into forest economy. The genetic bases of the individuals which are to be planted in the forest are also taken into consideration in a modern forest economy. This is why it is becoming practice that areas and plant individuals which are to be reserved for seed growing astigned to these purposes. The quantity of the seed required by nursery gardens is known from the projects of forest economy. There are however many cases when the reproduction capacity of the individual plants, and the survival ratio of the seeds grown in natural conditions are unknown.

In regard of Europe, we have data on the seed production and germination of Fraxinus excelsior L. (GARDNER 1977; VILLIERS and WAREING 1964, etc.) in regard of Africa, on *Turreanthus africana* Pellegr. (ALEXANDRE 1977); from North America, *Acer saccharum* Marsh. (HETT and LOUCKS 1971); as well as there are data on various oaks (GYSEL 1957; WOOD 1938, etc.). BARTON (1967) enumerates nearly 30 papers in the above sphere of topics, these however — with the exception of two (AGNISTIKOVA 1962 and SEDASHEVA 1953) — all deal with North-American tree species.

Data related to oaks in Hungary are to be found in the book by KERESZTESI (1967). Besides his work, the papers of MÁTYÁS (1965), NEMKY (1964), VINCZE (1966), and of FUISZ (1965) contain valuable information. Data on the reproductive capacity of *Quercus cerris* L. under natural conditions are however missing. Therefore, we started pioneering investigations

* Síkfőkút Project, Nr. 50.

on this topic, in respect of the Turkey oakwood stand of the Síkfőkút Project (JAKUCS 1973). In our paper we present the experimental results related to the period from October 1977 to October 1978.

Method

The ratio of *Quercus cerris* L. in the Turkey oakwood examined changes between 6—23%; the *Quercus cerris* L. trees stand in smaller groups (MAJER 1974). The average number of stand per ha of the Turkey oaks is 127 (JAKUCS, HORVÁTH and KÁRÁSZ 1975).

We marked 50 sample trees in a forest area of some 6 ha. In places chosen randomly, at a distance of 1.5—2 m from the trunk, we delimited with nylon strings permanent quadrate of 1 m² and made observations there.

The first samplings could be carried out in the period between 31 March and 5 April, 1978. We counted the cups fallen in the quadrat from the 1977 crop. The older cups could be reliably separated from the new ones on the basis of the well visible signs of litter decay.

We supposed that with a great certainty the same number quantity of ripe acorn fell into a quadrat as was that of the empty cups found there. Certain differences are obviously possible, but these balance each other. This is also proved by our data. Then the number of acorns was registered which had been found in the quadrat either as having been after germination, or destroyed after germination, or partly consumed by rodents, partly damaged by insects, or which did not germinate due to the effect of fungus or some other reasons. We did not have to reckon with the possibility that also the acorns of *Quercus petraea* (Matt.) Liebl. will be counted, since in the preceding years this oak species did not bring fruit. The results of our examinations are given in piece/m² values.

The quadrats were reexamined between 1 and 15 August, 1978, and the number of living seedlings was counted, piece/m². The reproductive capacity of the 50 sample trees in 1977—1978 was calculated as follows:

$$C_r\% = \frac{\text{fallen acorn, pieces/m}^2\text{, in autumn 1977}}{\text{number of living seedlings pieces/m}^2\text{, in summer 1978}} \times 100$$

The way of counting the mortality:

$$M\% = \frac{\text{total number of living seedlings, pieces/m}^2\text{, in summer 1978}}{\text{total number of germinated acorns, pieces/m}^2\text{, in spring 1978}} \times 100$$

Between 26 October and 16 November, the total acorn crop of 5 randomly chosen Turkey oaks was gathered and selected into groups of sound and damaged of fruits, for making comparisons. The approximate value of the annual fruit production per ha was obtained by multiplying the average weight falling to one tree of the total crop by the average trunk number per ha.

For estimating the quantity of ripe fruit of the fruits that started to grow, we examined the material brought into the laboratory from the litter-collecting boxes placed out in the sampling area, and having a total surface of 10 m² (cf. TÓTH, B. PAPP and JAKUCS, mscr.). The litter was sorted out into fractions (branch, leaf, fruit, etc.), and the number of undeveloped fallen fruits at the time of sampling and those of developed empty cups, were counted. Although the cups that had fallen by 1 June, 1978, still belonged to the crop of 1977, they were also considered so that the number of cups that remained on the tree in the winter of 1978 could be compensated.

Results and Discussion

Soon after the fructification of the flowers, the falling of the growing fruits sets out (Table 1). On the basis of the material brought is from the litter-collecting boxes we stated that the number of undeveloped fruits fallen together

Table 1

Seasonal changes in the number of undeveloped fruits fallen into the litter-collecting boxes and of the matured cups

	1. XII. 1977–21. V. 1978	21. V.–1. VI. 1978	1. VI.–1. VII. 1978	1. VII.–1. VIII. 1978	1. VIII.–1. IX. 1978	1. IX.–1. X 1978	1. X.–1. XI. 1978	1. XI.–1. XII. 1978	Total
Number of undeveloped fruits, pc.	19	1	137	102	363	108	91	21	842
Number of matured cups, pc.	84	1	1	0	1	20	157	49	313
Total	103	2	138	102	364	128	248	70	1155

Table 2

Total sums of fruit values related to permanent quadrats (50 altogether) under Quercus cerris L. sample trees (31. II. 1978—15. VIII. 1978)

1	2	3	4	5	6	7	8	9	10	11	12
	Total fallen acorn	No. of acorns that have germinated of the total	No. of acorns with sound shootings (from 3)	No. of acorns that have decayed after germination	No. of acorns consumed by rodents	Consumed by insects	Funguses, and other damaged	No germination	Total of damaged acorns	Missing acorns	Seedlings that were alive on 15. VIII. 1978
Σ pc/50 m²	4675	1620	1243	377	178	255	340	49	1199	2233	893
$\bar{x}$ pc/m²	93.50	32.40	24.85	7.54	3.56	5.10	6.80	0.98	23.98	44.66	17.86
%	100.0	34.65	26.58	8.07	3.81	5.45	7.27	1.05	25.64	47.77	19.10

The data of columns 2—11 refer to a date of 5. IV. 1978.

with their cups (with a diameter of 4—15 mm) is especially high between 1 July and 1 October, it amounts to 84.3% of the total. The falling of ripe acorns in crowds begins after 1 October. In this period, the quantity of the undeveloped fruits considerably decreases.

The ratio of the fruits destroyed in the course of development to the ripe fruits is very high. Taking the total crop that started to grow as 100% (1155 pieces/10 m^2), the quantity of the ripe acorns is only 27.1%. Thus, only about every fourth of the fruits became fully on the average grown. And even also the latter are decimated by many damaging effect (Table 2).

The total quantity of the acorns fallen on the permanent quadrats, under the various sampling trees, shows great differences: it fluctuates between 23 pieces/m^2 and 270 pieces/m^2; on an average it is 93.5 pieces/m^2. Its distribution is not even, it can often be found in groups (Fig. 1).

The total weight of the acorns (without cups) collected from under 5 sample trees for the estimation of the crop in 1978 was 10.62 kg, while the average weight related to one tree was 2.12 kg, that is, 272 kg/ha (Table 3). This value fits into that of the annual crop quantities measured in the area since 1973 (Tóth, B. Papp and Jakucs, mscr.). The average weight falling to one acorn (3.43 g/piece) is rather low in comparison with the 5.5 g/piece basal-thousand-seed-weight given by Fuisz (1965). One of the reasons of this is that foresters use the weight of thousand seeds of the fruits suitable for reproduction in their calculation, while in our measurements also the weight and number of undeveloped or damaged acorns are drawn into the calculation. It can be seen from the data of Table 3 what differences do occur between the average values of sound and damaged acorns.

A considerable part of the quantity grown falls as damaged already in autumn, of the total crop of one tree, 1130 g (313 pieces), it was only 483 g, that is 42.7% that proved sound. This is 31.95% of the number of acorns (Table 3).

13.77% of the 1977 crop that still existed in the spring of 1978 was insect damaged (Balaninus sp.), or fungus damaged, or incapable of germination, while 3.81% of the crop was consumed by rodents. A considerable part of the crop (47.77%) was missing (Table 2). This is obviously a result of the activity of big games and rodents primarily. In winter, wild hogs also go regularly to the sampling area, for feeding on mast. During the samplings, we found under the litter many paths trodden by rodents. In the tracks we often saw acorns. When uncovering one of the tracks, we found 12 pieces of acorn drawn under the ground.

Rodents consume even germinating acorns. This is not always accompanied by a complete destruction of the germinating plant, for if 1/3 of the lobe lying near the radicule is sound, the seedling can still be viable. Most often the injury of root neck or drying out causes the decay.

Fig. 1. Acorns germinating in groups (Photo: M. NAGY)

After 10 months counted from the falling down of the crop the reproductive capacity measured in 1978 was $C_r = 19.1\%$ (Fig. 2). This corresponds to a value of $\overline{C}_r = 17.86$ piece/m²/10 months.

Table 3

Data of total product in 1978 of 5 Quercus cerris L. sampling trees (26. X. 1978)

	Serial number of sampling trees					Σ	$\bar{x}$
	1	2	3	4	5		
Total product, dkg	113	145	361	247	196	1062	212.4
Total product, pc	313	322	1332	551	585	3103	620.6
Average weight, g/pc	3.6	4.5	2.7	4.5	3.35	—	3.43
Number of acorns, consumed by rodents, pc	32	6	67	8	13	126	25.2
Average weight, g/pc	2.65	4.5	1.94	1.81	2.2	—	2.62
Number of acorns consumed by insects, pc	59	28	109	104	123	423	84.6
Average weight, g/pc	1.84	3.21	2.25	2.31	2.22	—	2.36
Funguses-damaged, pc	29	19	247	32	42	369	73.8
Average weight, g/pc	3.2	4.57	1.30	4.72	2.23	—	3.20
Other damage, piece	93	61	118	168	191	631	126.2
Average weight, g/pc	3.87	4.83	2.53	4.49	2.24	—	3.59
Total number of damaged fruits, piece	213	114	541	312	263	1443	288.6
Average weight, g/pc	3.04	4.38	1.84	3.71	2.23	—	3.04
Sound of the total crop, piece	100	208	791	239	322	1660	332
Average weight, g/pc	4.83	4.57	3.30	5.48	4.27	—	4.49
Its percentage related to the total number of pieces	31.9	64.6	59.4	43.3	55.0	—	53.6

In some places the seedlings appeared as dense as the hair of a brush; we counted 122 pieces in one of our quadrats. The general height of the seedlings is 11—14 cm; the maximum is 25.2 cm, while the minimum 4.1 cm (29 July, 1978).

We examined 65 pieces of seedlings collected by random sampling from the area of 6 ha separately (Table 4). The considerable weight ratio of the lobes
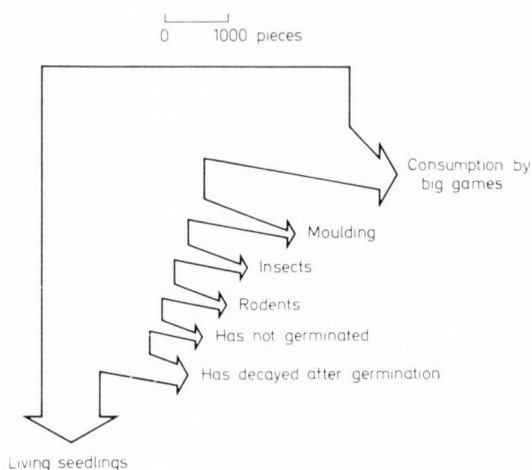
Fig. 2. Various losses and the reproductive capacity in comparison with the total acorn production (1977—1978) determined on the basis of data obtained from 50 permanent quadrats marked under *Quercus cerris* L.

Table 4

Average, minimum and maximum sizes of 6 months old seedlings in 65 pieces of Quercus cerris L. (1. X. 1978)

	$\bar{x}$	Minimum	Maximum
Length measures, cm			
aboveground part (stem)	15.46	9.0	26.0
belowground part (root)	17.50	10.0	28.5
full length	32.96	23.0	49.0
Diameter in lobe, mm	3.12	1.8	4.3
Weight, g			
root	0.91	0.22	2.40
stem	0.49	0.15	0.95
foliage leaf	0.41	0.1	0.74
lobe	2.14	0.6	5.6
total weight	3.95	1.26	7.93
No. of foliage leaves, piece	5	2	10
Surface of one leaf, cm²	15.45	3.79	25.82
Total leaf surface of one seedling, cm²	75.54	19.58	180.40
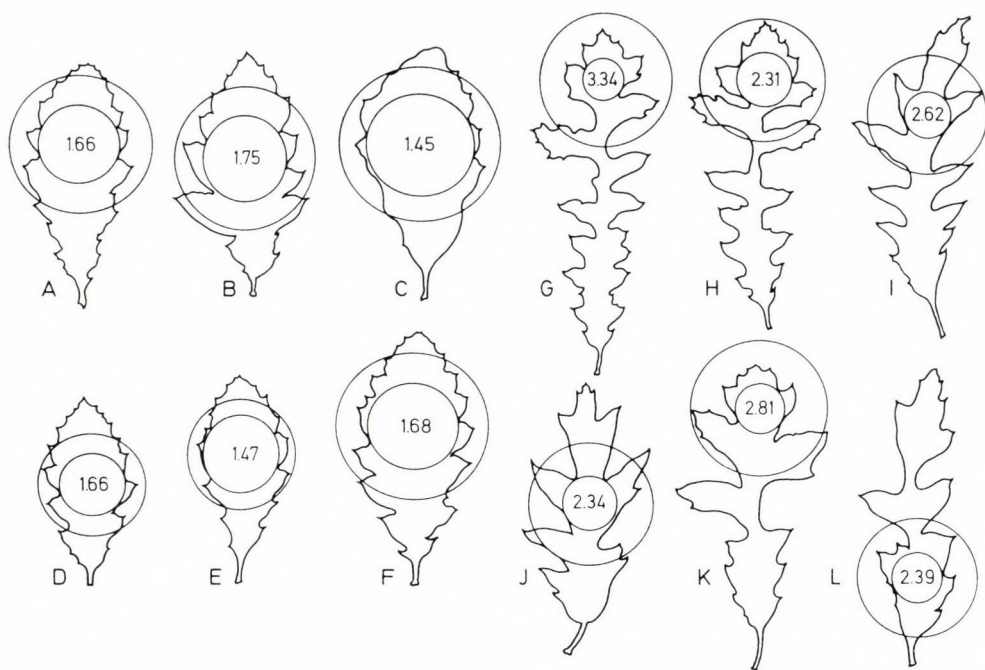
Fig. 3. Lobular ratio (LR) of *Quercus cerris* L. leaves. A—F: seedlings; G—L: leaves of the fully-developed trees. The inner circle is the greatest drawnable into the leaf, the outer circle is of identical size with that of the leaf (after HORN 1971). The ratio of their radii provides the value of LR (the number written into the inner circle)

still present on the germinating plant (2.14 g/pieces, 54.2% of the total weight) is remarkable. The leaves of the seedlings are only to a small extent lobular (Fig. 3), we do not even find deeply lobular ones among them.

The lobe ratio (LR) was calculated as follows:

$$LR = \frac{r_1}{r_2}$$

where r_1 = radius of the circle equal in surface to that of the leaf
r_2 = the radius of the greatest circle that can be drawn into the leaf blade.

The minimum length of one year old Turkey oak seedlings grown in tree nurseries is 14 cm, the diameter of the stem above the root head is 3 mm (KERESZTESI 1967). On the basis of this it can be stated that the average sizes of the natural seedlings examined by us do not considerably differ from those of plants in similar age and grown in nurseries.

There are many germinating plants that decay at an early phase of ger-
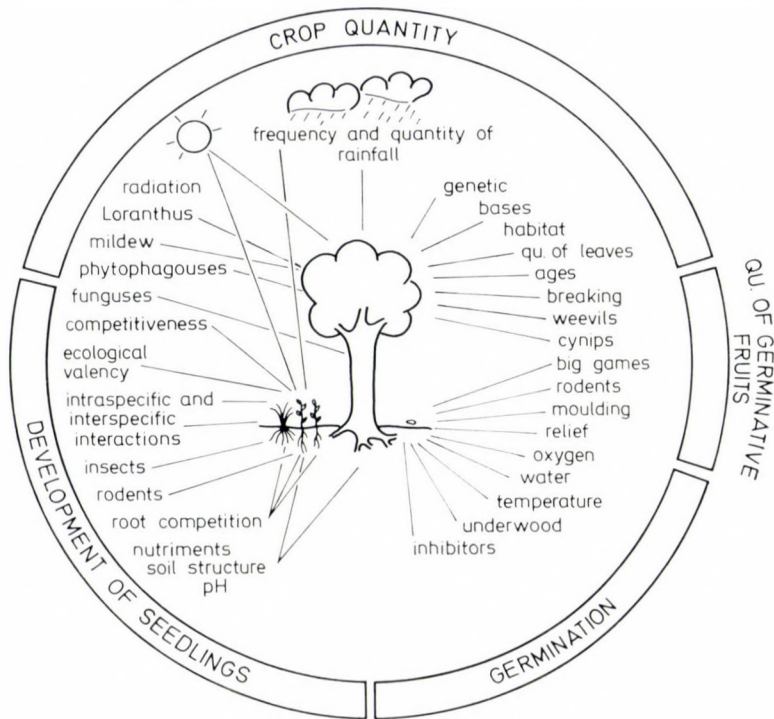
Fig. 4. Main effects influencing the reproductive capacity of Turkey oak

mination. The mortality of the acorns that have germinated in spring was M = 88% during 4 months, while the average mortality was 14.54 pieces/m^2/ 4 months, that is only 55.12% of the germinated plants were still alive in the autumn of 1978. In the following years, under the effect of biotic and abiotic factors, the mortality will increase; therefore, the permanent quadrats will for several years be paid attention to.

The quantity and quality of the crop, as well as the vitality of seedlings originating from it are modified by a combined effect of many factors. In Fig. 4 we present these important factors which have influence on the reproductive capacity of the oak. The effects are divided into four groups:

- factors determining the quantity of crop
- factors determining the germination capacity of fruits
- factors determining the germination of fruits having germination capacity
- factors determining the growth of seedlings.

The complicated linking of the main interactions demonstrated in the Fig. 4 give an explanation of the data being very different by the various individuals, by years and by habitats.

REFERENCES

AGNISTIKOVA, V. N. (1962): Effect of moisture of acorns on their germination capacity. Akad. Nauk. SSSR Laboratoriya Lesovedenija Fiziol. drevesnika rastenii, 104—111.

ALEXANDRE, D. Y. (1977): Régénération naturelle d'un arbre caractéristique de la foret équatoriale de Cote-d'Ivoire: Turreanthus africana. Pellegr. Oecol. Plant, **12,** 241—262.

BARTON, L. V. (1967): Bibliography of Seeds. Columbia University Press, New York, London.

FUISZ, J. (1965): Az erdei magvak vetőértékének gyors meghatározása (A quick determination of the reproductive capcity of forest seeds). Erdészeti Kutatások, **61,** 75—97.

GARDNER, G. (1977): The reproductive capacity of Fraxinus excelsior on the Derbyshire limestone. J. Ecol. **65,** 107—118.

GYSEL, L. W. (1957): Acorn production of good, medium and poor oak sites in southern Michigan. J. Forestry **55,** 570—574.

HETT, J. M.—LOUCKS, O. L. (1971): Sugar maple (Acer saccharum Marsh) seedling mortality. J. Ecol. **59,** 507—520.

HORN, H. S. (1971): The adaptive geometry of trees. Princeton University Press, Princeton, New Jersey.

JAKUCS, P. (1973): "Síkfőkút Project". Egy tölgyes ökoszisztéma környezetbiológiai kutatása a bioszféra program keretein belül (Síkfőkút Project. Environmental-biological research of an oakwood ecosystem, within the framework of the biosphere program). MTA Biol. Oszt. Közl. **16,** 11—25.

JAKUCS, P.—HORVÁTH, E.—KÁRÁSZ, I. (1975): Contributions to the aboveground stand structure of an oak forest ecosystem (Quercetum petraeae-cerris) within the Síkfőkút research area. Acta Biol. Debrecina, **12,** 149—153.

KERESZTESI, B. (1967): A tölgyek (The oaks). Akadémiai Kiadó, Budapest.

MAJER, A. (1974): A cseres-tölgyesek fatermési és erdőművelési vonatkozásai a Síkfőkút Project faállományainak elemzése alapján. (Implications of wood product and forest culture of Turkey oaks, on the basis of analyses into the wood stands of the Síkfőkút Project). Erd. és Faip. Egy. Tud. Közl. **3,** 51—63.

MÁTYÁS, V. (1965): Ökológiai megjegyzések a tölgy és a bükk termésének időszakosságához (Remarks on periodicity of fruit production in the oak and beech). Erdészeti Kutatások, **61,** 99—121.

NEMKY, E. (1964): A tölgymakk víztartalmának befolyása a fagyérzékenységére és a csírázás megindulására (Effect of water content on the sensitivity to frost and on the starting of germination in oak acorn). Egy. Tud. Közl. **1,** 43—62.

SEDASHEVA, G. I. (1953): On the dormancy period in oak. Lesn. Khoz. **6,** 35—37.

TÓTH, J.—B. PAPP, L.—JAKUCS, P. (mscr.): A fásszárúak éves avarprodukciója (The annual litter production of woody plants). In: JAKUCS, P. (ed): Studies on the oak forest ecosystems of the Pannonicum. Results of "Síkfőkút Project".

VINCZE, E. (1966): A rovarkárosított tölgymakk hullási periódusai (The falling periods of acorns of oaks damaged by insects). Erdészeti Kutatások **62,** 327—333.

VILLIERS, T. A.—WAREING, P. F. (1964): Dormancy in fruits of Fraxinus excelsior L. J. exp. Bot. 15, 359—367.

WOOD, O. M. (1938): Seedling reproduction of oak in Southern New Jersey. Ecology, **19,** 276—293.

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NUEVOS REPORTES PARA LA FLORA HEPATICOLOGICA DE AMÉRICA LATINA, I.

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26 liverworts reported from Latin America, mostly the collections made by the author, and other materials deposited in HAC and in EGR. 6 of them are new for Cuba: *Aphanolejeunea ephemeroides* Schust., *Colura greig-smithii* Jov.-Ast., *Colura tenuicornis* (Evans) Steph., *Drepanolejeunea lichenicola* (Spruce) Steph., *Prionolejeunea helleri* Evans, and *Radula pallens* (Swartz) Dum., and 3 for other Latin American countries.

La determinación de especies de hepáticas colectadas por la autora en la Gran Piedra (provincia Santiago de Cuba), asi como la determinación de material depositado en el herbario del Instituto Pedagógico de Eger en Hungria (EGR), dieron motivo a este artículo que da a conocer nuevos reportes para le flora hepaticológica de América Latina. Son reportadas 26 espécies de hepáticas: 6 espécies de nuevo reporte para Cuba (**); 11 espécies reportadas por primera vez para el área de La Gran Piedra (*); y 3 espécies de nuevo reporte para otros países de América Latina (!):

Aphanolejeunea ephemeroides Schust. — Cuba, Gran Piedra, 1100 m (a continuación — GP), c. REYES 2573, EGR, HAC.

*****Aphanolejeunea evansii** Schust. — GP, c. REYES 2710, HAC, EGR.

*****Aphanolejeunea sicaefolia** (Gott.) Evans — GP, c. REYES 2701, HAC, EGR.

Bonneria bifida (Steph.) Schust. — GP, c. REYES 2751, HAC, EGR.

!**Brachiolejeunea insularis** Evans — Belize, c. SPELLMAN y STODDART B128b, MO 1276, HAC, EGR.

*****Ceratolejeunea variabilis** (Lindenb.) Schiffn. — GP, c. REYES 2762, HAC, EGR.

Cheilolejeunea rigidula (Nees et Mont.) Schust. — GP, c. REYES 2779, HAC, EGR.

!**Cololejeunea scabrifolia** Gott. ex Steph. — Trinidad, Valencia, c. BRITTON 1838, EGR, HAC.

*****Colura calyptrifolia** (Hook.) Dum. — GP, c. REYES 2702, HAC, EGR.

******Colura greig-smithii** Jov.-Ast — GP, c. REYES 2714, HAC, EGR.

******Colura tenuicornis** (Evans) Steph. — GP, c. REYES 2714 p.p., HAC, EGR.

*****Cyclolejeunea convexistipa** (Lindenb. ex Lehm.) Evans — GP, c. REYES 2752, HAC, EGR.

Drepanolejeunea crassiretis Evans — GP, c. REYES 2718, HAC, EGR.

******Drepanolejeunea lichenicola** (Spr.) Steph. — GP, c. BORHIDI y MUÑIZ 1551, EGR, HAC.

Kurzia capillaris (Swartz) Grolle — GP, c. REYES 2726, HAC, EGR.

*****Lejeunea flava** ssp. **flava** (Swartz) Nees — GP, c. REYES 2779, HAC, EGR.

*****Lejeunea laetevirens** Nees et Mont. — GP, c. REYES 2731, HAC, EGR.

*****Leptoscyphus ovatus** (Spr.) Grolle — GP, c. REYES 2725, HAC, EGR.

*****Lophocolea bidentata** (L.) Dum. — GP, c. REYES 2795, HAC, EGR.

Neurolejeunea breutelii (Gott.) Evans — GP, c. REYES 2727, HAC, EGR.

!**Odontolejeunea lunulata** (Web.) Schiffn. — Bolivia, Coroico, c. MAHUNKA 79/a, EGR, HAC.

Prionolejeunea helleri Evans — GP, c. REYES 2708, HAC, EGR.

*Radula longifolia** Steph. — GP, c. REYES 2779, HAC, EGR.

*Radula macrostachya** Lindenb. et Gott. — GP, c. REYES 2751, HAC, EGR.

Radula pallens (Swartz) Dum. — GP, c. REYES 2752, HAC, EGR.

Telaranea nematodes (Gott. ex Aust.) Howe — GP, c. REYES 2755, HAC, EGR.

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REFERENCIAS

ARNELL, S. (1956): Hepaticae collected in Cuba and Hispaniola by EKMAN. The Bryologist **53,** 271—276.
BISCHLER, H. (1964): Le genre Drepanolejeunea Steph. en Amérique Centrale et Méridionale. Rev. Bryol. et Lichén. **33,** 15—179.
CASTLE, H. (1966): A revision of the genus Radula, part II. Subgenus Acroradula, Section 10, Ampliatae. Rev. Bryol. et Lichén. **34,** 1—81.
CASTLE, H. (1967): A revision of the genus Radula, part II. Subgenus Acroradula, Section 11, Complanatae. Rev. Bryol. et Lichén. **35,** 1—94.
EVANS, A. W. (1904): Hepaticae of Puerto Rico. IV. Odontolejeunea, Cyclolejeunea and Prionolejeunea. Bull. Torr. Bot. Club **31,** 183—226.
EVANS, A. W. (1905): Hepaticae of Puerto Rico. V. Ceratolejeunea. Bull. Torr. Bot. Club **32,** 213—290.
EVANS, A. W. (1908): Hepaticae of Puerto Rico. IX. Brachiolejeunea, Ptychocoleus, Archilejeunea, Leucolejeunea and Anoplolejeunea. Bull. Torr. Bot. Club **35,** 155—179.
FULFORD, M. (1966): Manual of the leafy Hepaticae of Latin America, part II. Mem. N. Y. Bot. Garden **11,** 173—276.
GROLLE, R. (1962): Monographie der Lebermoosgattung Leptoscyphus Mitt. Nova Acta Leop. 161; n.s. **25,** 1—143.
GROLLE, R. (1975): Lebermoose aus Kuba (1). Wiss. Ztschr. Fr. Schiller Univ. Jena **24,** 397—400.
JOVET-AST, S. (1953): Le genre Colura. Rev. Bryol. Lichén. **22,** 206—312.
PAGÁN, F. M. (1939): A preliminary list of the Hepaticae of Puerto Rico including Vieques and Mona Island. The Bryologist **42,** 1—12, 37—50, 71—82.
PAGÁN, F. M. (1942): Catalogue of the Hepaticae of Guadeloupe. The Bryologist **45,** 76—110.
SCHUSTER, R. (1955): North American Lejeuneaceae II. Paradoxae; the genera Aphanolejeunea and Leptocolea. Jour. Elisha Mitchell Soc. 71, 126—148.
WELCH, W. (1950): A contribution to the Bryophyte of Cuba. The Bryologist **53,** 238—243.

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NOMINA NOVA IN GENERE OPHRYS

By

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Author describes 4 new combinations and 4 new hybrids of the genus *Ophrys* and make some taxonomic remarks in relations of this genus. New combinations: *Ophrys omegaifera* Fleischmann var. *fleischmannii* (Hayek) Soó and var. *dyris* (Maire) Soó, *O. tommasinii* Vis. ssp. *arenicola* (Rchb. f.) Soó, *O. kurdica* Rückbrodt ssp. *kurdistanica* (Renz) Soó. New hybrids: *O.×gumprechtiana* Soó, *O.×waldmanniana* Soó, *O.×baumanniana* Soó, *O.×grafiana* Soó.

Combinationes novae

Ophrys omegaifera FLEISCHMANN 1925 Öst. Bot. Zschr. 74: 184 (microsp. agg. *O. fusca*, uti etiam *O. atlantica* MUNBY 1856 [*fusca* subsp. *durieui* (RCHB. F.) Soó 1927, nomen pro subsp. legitimum] et *O. pallida* RAF. 1810. — var. **fleischmannii** (HAYEK 1926 Fedde Repert. 22: 388 p. sp.) Soó **comb. n.** (Soó 1926 p. subsp. *O. fuscae*, 1973 p. var. *O. fuscae*) — var. **dyris** (MAIRE 1931, Bull. Soc. Hist. Nat. Afr. Nord. 22: 65 p. sp.) Soó **comb. n.** (Soó 1933 p. subsp. *O. fuscae*, KELLER 1940 p. subsp. *O. atlanticae*).

O. tommasinii VIS. 1852 Fl. Dalm. 3: 354 (incl. *O. litigiosa* CAMUS).

Plantae affines, sed non identicae, cf. Soó in Fl. Eur. 5. (1979), Acta Bot. Hung. 18: 380 (1973).

O. tommasinii: Flores normaliter 3–5, rarius plures, petala trinervia, labellum 6–10×6–10 mm, pallide brunneum, papillose subvillosum, gibbae basales parvae, sed conspicuae. Jugoslavia (Istria–Corfu), Graecia NW, Creta, Rhodos?

O. litigiosa: Flores normaliter 6–10, rarius pauciores, petala uninervia, labellum 5–8×5–8 mm, pallide vel flavescenti- vel atro-brunneum, papillose-velutinosum, gibbae basales normaliter nullae. Mediterraneum W: Gallia, Germania, Helvetia, Hispania, Italia?, Graecia (raro).

Nomina specifica antiquissima legitima: *O. tommasinii* VIS. l.c. resp. *O. litiginosa* CAMUS Journ. Bot. 10: 1—3 (1896), pro subsp.: *O. sphegodes* MILL. subsp. *tomm.* Soó 1970 resp. *litigiosa* BECHERER 1925, sed veterius: *O. araneifera* subsp. *araneola* (RCHB. F. Icon. Fl. Germ. 1951: 89 p. var.) RICHTER Pl. Eur. 1: 263, ideo nomen legitimum *O. tommasinii* VIS. subsp.

araneola (RCHB. F. l.c.) Soó **comb. n.** Synonymon est etiam *O. sphegodes* subsp. *pseudospeculum* (RCHB. F. p. var.) KELHOFER sed non *O. pseudospeculum* DC. 1815 p. sp., cujus planta — sec CAMUS et ROUY —: *O. lutea*×*scolopax* (sed dubia).

O. kurdica RÜCKBRODT 1975 subsp. **kurdistanica** (RENZ 1978 Fl. Iran. Orchidaceae 83 p. sp.) Soó **comb. n.** ab *O. kurdica* specifice non differt.

O. phrygia FL. et BORNM. 1923 (*cilicica* SCHLECHT. 1923) me judice ad speciem (agg.) *O. reinholdii* SPRUNER ex Fl. 1908 pertinet, cf. icones in KELL. Mon. Icon. 3: T. 15, fig. 5, NELSON Gestaltwandel . . . *Ophrys* T. LV. nr. 8, 15—16 identicae.

O. oestrifera M. B. 1808 Fl. Taur. Cauc. 2: 369 est me judice microsp. agg. *O. scolopax* distincta (cf. Soó Acta Bot. Hung. 16: 386 (1970), Fl. Eur. 5. (1979), ab *O. cornuta* bene diversa. In casu contractionis taxorum duorum est uti nomen specificum antiquius — et legitimum —, quam *O. cornuta* STEVEN 1809 Mém. Soc. Mosq. 2: 175. — Nomina recta: *O. oestrifera* M. B. (*scolopax* subsp. *oestrif.* Soó 1970) *subsp. oestrifera, subsp. cornuta* (STEV.) RICHTER 1890, Soó 1931 (*scolopax* subsp. *cornuta* CAMUS 1908).

Hybridae hucusque non rite descriptae

Ophrys×gumprechtiana Soó nom. n.

Ophrys fusca×*garganica* Gumprecht Orchidee 21: 355 (1970) (*O.*×*pseudofusca* Albert et Cam. nm. *gumprechtiana*) germanice descripta.

Planta 20—40 cm, flores 2—5. Bracteae angustae, ovariis longiores. Sepala viridia, ovata, praecipue medianum (uti O. fuscae). Petala viridia-fusca, longiora, quam in O. fusca, angustiora O. garganicae. Labellum subtrilobum vel integrum, egibbosum, parte medio papillosum, margine pilosum. Macula coerulea vel candida resp. albomarginata, bipartita vel H-formis. Area basalis parva, incisura alba, triangularis, calla basalia pallida, appendix connectivi nulla.

Italia, Mte Gargano: Sipontea; Holotypus Herb. Gumprecht, Freiburg.

O.×waldmanniana Soó nom. n.

[*O. speculum*×*ferrum-equinum* Waldmann Orchidee 22: 206 (1971) germanice descripta. Tab.]

Planta cca 20 cm. Sepala anguste vel late ovata, pallide olivacea, inferius purpureum. Petala basi lata, lanceolata, obtusa vel acuta, sepalis ter breviora, margine albopilosa. Labellum trilobum, lobi laterales margine pilosi, vix gibbosi. Macula coerulea, margine pallidior. Calla basalia adsunt, appendix vix evoluta.

Graecia, mt. Hymettos. Holotypus Herb. Waldmann, Kassel.

O. × baumanniana Soó **nom. n.**

[*O. sphegodes × cretica* Baumann Orchidee 23: 206 (1972) germanice descripta.]

Planta cca 15 cm, flores 2—3. Sepala pallide flavoviridia, lateralia roseo diluta. Petala purpurascenti-viridia, sepalis cca ter breviora. Labellum purpureo-brunneum, lobus medius paullo trilobum, margine resupinatus, gibbae parvulae. Macula argentea bipartita (lineis duabus). Area basalis concava, calla basalia reducta, appendix parva, viridis.

Creta: Siva. Holotypus Herb. Baumann, Böblingen.

O. × grafiana Soó **nom. n.**

[*O. bombyliflora × carmeli* subsp. *attica*, Graf Orchidee 29: 149 (1977) germanice — insufficienter — descripta.]

Planta 12 cm, flores 2—3. Sepala viridia, medianum provergens, petala viridia vel cano-viridia, sepalis ter breviora, labellum inter parentes intermedium, macula dissoluta, indumentum labelli uti O. bombyliflorae, appendix parva.

Graecia, Corcyra (Korfu): Pirgi. Holotypus: Herb. Graf. Dübendorf.

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SIGNIFICANCE OF ANATOMICAL FEATURES OF THE SHOOT IN THE SYSTEMATICS OF HUNGARIAN GENTIANA

By

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The stem and leaf anatomy of three Hungarian species of *Gentiana*, namely, *G. pneumonanthe*, *G. cruciata* and *G. asclepiadea* has been studied. In the case of *G. cruciata* five characters appear to be significantly affected by the environment, whereas only two of *G. asclepiadea* and two of *G. pneumonanthe*. The number of papillose cells per quadrate on the leaf margin also varies among the three species. Significant correlations have been found between the area of main vascular bundle and bundle sheath parenchyma in *G. cruciata* and between the area of the 1st lateral bundle and bundle sheath parenchyma in *G. asclepiadea*. The length of the stomata in all the three species exhibits a higher diversity value than the breadth.

We have detected 5 stem and 6 leaf characters which are common in the three species and may be useful for some other species of *Gentiana* too, as diagnostic features. As expected on the basis of morpho-taxonomic study *G. cruciata* and *G. pneumonanthe* show a more closer affinity with the anatomy of the stem than *G. asclepiadea*. Therefore this supports the present taxonomic treatment of the three species.

Introduction

This paper is a part of a series of our study on Hungarian *Gentiana*. First a numerical evaluation of exomorphic characters was carried out with a view to justifying the exclusion of *G. ciliata* from *Gentiana* to *Gentianella* (SZUJKÓ-LACZA and SEN 1977a, b, c, d).

The results of our study indicate that *G. ciliata* has a very low degree of affinity with the other three species, *viz. G. pneumonanthe*, *G. cruciata* and *G. asclepiadea*, so its treatment under *Gentianella* seems to be more probable. In the second part of this series we have delt with the distribution, diversity and equitability of three species, namely *G. pneumonanthe*, *G. cruciata* and *G. asclepiadea*. The present paper deals with the anatomy of stem and leaves of the same three species.

Gentiana is a poorly known taxa from an anatomical point of view, except the rhizome or root of some species which is known from medicinal purposes.

METCALFE and CHALK (1950) have compiled some works on the anatomy of leaves and stems of *Gentiana*. LÄMMERMAYER (cf. HEGI 1906) investigated fat-like substances in different organs of *G. asclepiadea*.

KÜSTER (1956), KAUSSMANN (1963) and ESAU (1969) reported on the primary cork and wall formation and pectin containing cells of endodermis in the root of *Gentiana* species. GOPAL KRISHNA and PURI (1962) investigated in detail the morphology of the flower of some

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Gentianaceae, including nine species of *Gentiana*. They clarified the vascularization of the reproductive organs and also the placentation for numerous species.

GULATI (1969) made a general survey of the anatomical characteristics on the reproductive organs of *Gentianaceae* and KSEHTRAPEL (1969) delt with the floral evolution of *Gentianales*.

The anatomical studies of *Gentiana* species deserve special attention to two counts. Firstly, the anatomy of *Gentiana* species has not been properly studied. Secondly, a comparative study of anatomical characteristics in conjunction with morphological features may clarify the taxonomic and phylogenic relationship among the taxa of this genus. A comparative study of the stem and leaf anatomy of the three species of *Gentiana* mentioned above was carried out to establish the anatomical relationship in terms of similar and diagnostic features among the three species taken together, and between the members of different species pairs. These as well as our findings on morphological characters may help to clarify the taxonomy of these species with respect to each other.

Material and methods

Fresh material of *G. pneumonanthe* and *G. asclepiadea* were collected by us from the village Szakonyfalu and Farkasfa of the county Vas during October, 1976. *G. cruciata* was received by courtesy of Mr. Kováts who collected it from Bükk mountains (county of Borsod). All collections were made at the late flowering stage. For anatomical investigations we used three plant samples in each species. First the samples were taken from each stem internode. Free-hand cross- and tangential sections were prepared from the middle portion of the internode of all the three plants. Moreover, the first, third and the terminal internode were cut into five equally long pieces and the cross-sections were made from the upper part of each piece, according to SZUJKÓ-LACZA 1977. After this preliminary investigation the section samples were taken from the middle of the first, third and terminal internodes (Fig. 1). By this method the difference(s) could be examined among the internodes in space and the sections taken from the different levels of the stem also reflect the age differences among the internodes, from the first and oldest to the last-terminal and youngest one. So we can read some processes by the serial sequence of internodes, namely what happened in the internodes during this time (i.e. the cell wall thickening process).

The leaves were collected from the middle of all the three stems and the anatomy of leaves was studied on microtome sections of 10 μm thickness taken from the middle portion of lamina (Fig. 1). The material was fixed in Nawashin solution, embedded in paraffin and stained toluidine blue. From each leaf sample three cross-sections were studied and the average mean values were used for each leaf as basic data. The number of papillose cells in a square in the leaf margin and the number of stomata in a square were counted from the five leaves originating from 5 different plants. The leaves were selected from the same position as in the other investigations (Fig. 1). The counting process for the correlation coefficient was based on Breaves's method, the analysis of variance was according to SVÁB (1967). The diversity has been determined according to SHANNON's model (1948) and for evenness (E) we have followed Pielou.

The anatomical characters of the leaf are marked by c (Table 1) and each character has a series running index (c_1, c_2, c_3 . . .). For a convenient determination of the correlation coefficient, the values of the character number c_2 (Area of mesophyll tissues and secondary veins) have been divided by 10,000 and c_5 (number of vascular in a unit area) multiplied by a hundred.

Key to abbreviations applied in the figures: b = bundle sheath parenchyma, c = cork parenchyma, cr = crystal, cu = cuticle, e = epidermis, end = endodermis, e ph = extraxylary phloem, g = stoma guard cell, h = hypoderma, i = intercellular space, i ph = intraxylary phloem, in = inner phloem, m = mucilage cell, me = medullary phloem, n = nucleus, o p = origin of papillae, p = pore, pa = parenchyma, pap = papillose cell, pe = pericycle, ph = phloem, pi = pith, pp = palisade parenchyma, r = rib (wing), ra = ray cell, s = sclerenchyma fiber, sc = sclerenchyma cylinder in the outer xylem, sec = secretory canal, so = solitary xylem element, sp = spongy parenchyma, st = stomata, t = trachaea, t c w = thickened cell wall, ti = tracheida, tr = transitional cell, tra = transporting zone in the xylem, x = xylem, vb = vascular bundle.
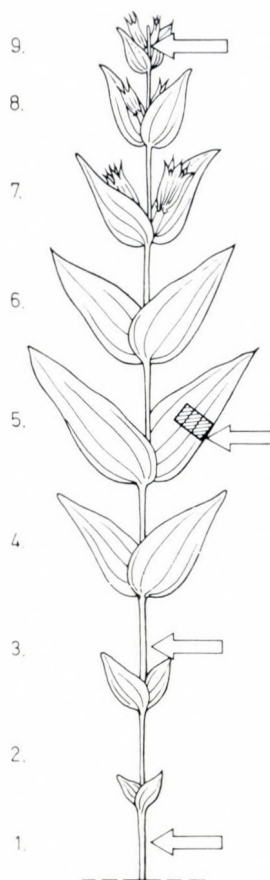
Fig. 1. Gentiana asclepiadea, habitus

Result and discussion

Stem anatomy:

Common characters:

A) Among three species

1. Stem ribbed (Figs 7, 8, 11, 12).
2. The primary cortex often lacunar or sometimes compressed (Figs 2, 9, 12, 13, 20, 26).
3. Endodermis well-defined (Figs 2, 8, 9, 12, 15, 16, 20, 26).
4. Outer external phloem present (Figs 2, 7, 8, 9, 10, 12, 13, 14, 15, 21).
5. In the pith there are isolated xylem elements (Figs 5, 7, 19, 25).
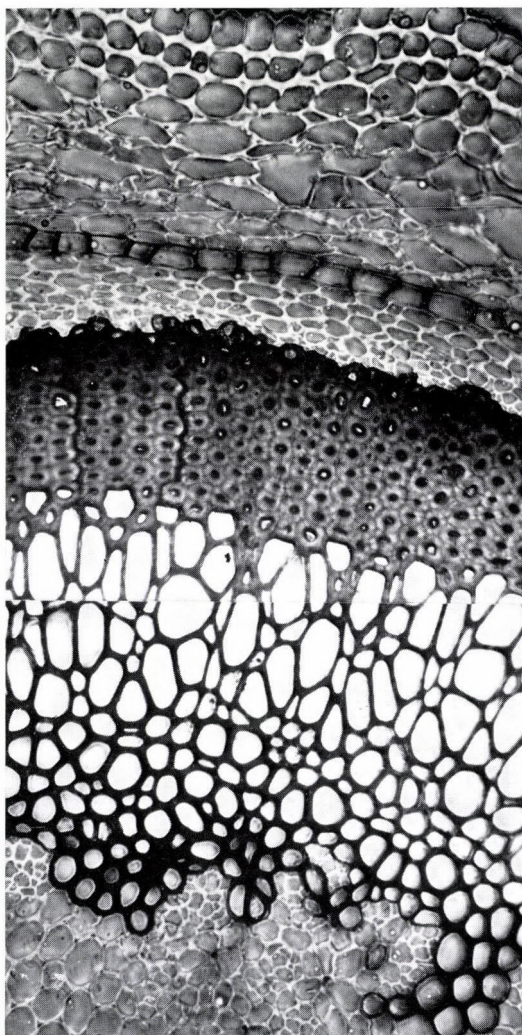
Fig. 2. Gentiana asclepiadea, 1st internode. Cross-section (cs) of stem 300×

B) Similarity between two species pair respectively:

a) Characters between *G. cruciata* and *G. pneumonanthe:*

From the anatomical point of view these two species appear to be more closer to each other, particularly with respect to stem anatomy. The common features between them are:

1. Absence of intraxylary phloem (Figs 21, 26, 27).
2. Presence of ray cells in xylem cylinder (Figs 21, 22, 24, 25, 26, 27).
3. The cell wall thickening of the xylem elements gradually decreasing from the extraxylary phloem to the pith cells. The cell groups of the intraphloem — found near the xylem cylinder — (Figs 21, 22, 27).

Fig. 3. Gentiana asclepiadea, 1st internode. Tangential section (ts) 300×
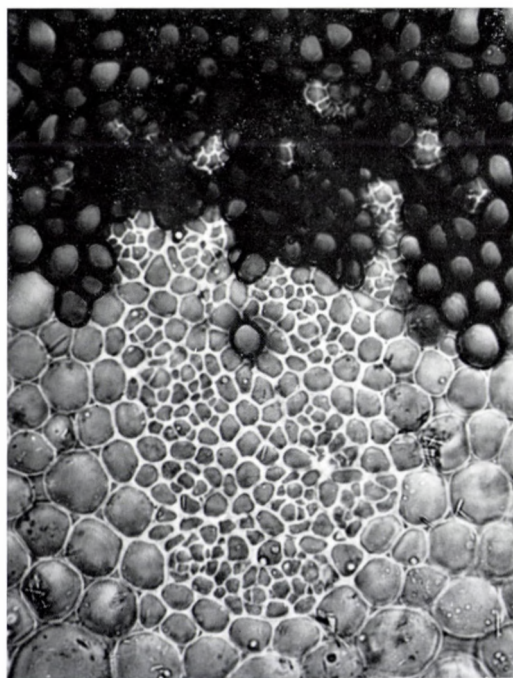
Fig. 4. Cs. stem showing xylem, inter and intraxylary phloem and solitary xylem element in the pith parenchyma, in *Gentiana asclepiadea*, 1st internode 300×
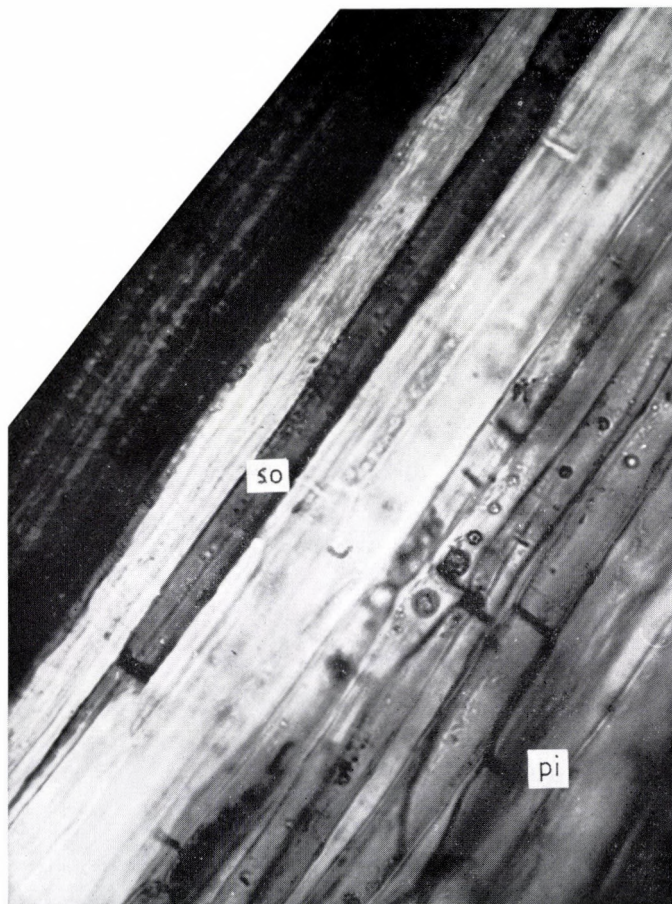
Fig. 5. Gentiana asclepiadea, 1st internode (ts). Solitary xylem in the pith 300×

4. Scattered groups of phloem cells, being surrounded by a layer of parenchymatous layer. Round the phloem cells may be bundle sheath because the cells contain weakly-green chloroplasts. The pith cells differ from each-other in size and shape due to the presence of phloem groups with parenchymatous sheath (Fig. 5).
5. Pericycle 1-cell wide, thin-walled tissue (Figs 15, 16, 26).
6. Mucilage cells are present in the cortex (Figs 20, 26).

b) Character between *G. cruciata* and *G. asclepiadea:*

1. The epidermis is devoid of papillose cells (Figs. 2, 7, 8, 9, 11, 15, 20, 24).

c) Character between *G. asclepiadea* and *G. pneumonanthe:*

There is no character which is common only to these two species.

Fig. 6. Gentiana asclepiadea, 3rd internode. Pith parenchyma cells, differ in size (ts) 300×

C) Diagnostic features:

G. asclepiadea:

1. The cortex may contain secretory canals and endothelial cells (Figs 2, 8).
2. Primary cortex cells with continuous thickened walls (Figs 2, 9, 12, 13).
3. Xylem consisting of two distinct concentric zones, the outer sclerenchymatous zone is much developed but gradually decreasing toward apex (Figs 2, 3, 7, 10, 13, 14). The inner one is the transporting zone (Figs 2, 7, 10, 11, 12, 13, 14). (Among the three species it has tall, thin, upright shoots, contrary to the *G. cruciata*, which is semi-lying.)
4. In the xylem the sclerenchymatous zone forming a close cylinder without discernible ray cells (Figs 2, 7, 10, 14).
5. The inner zone of xylem (the transporting one) being composed of numerous vessels accompanied by a little parenchyma (Metcalfe and Chalk (l.c.), and (Figs 2, 10). Its thickness decreases in an upward direction (Figs 2, 7, 10, 11).
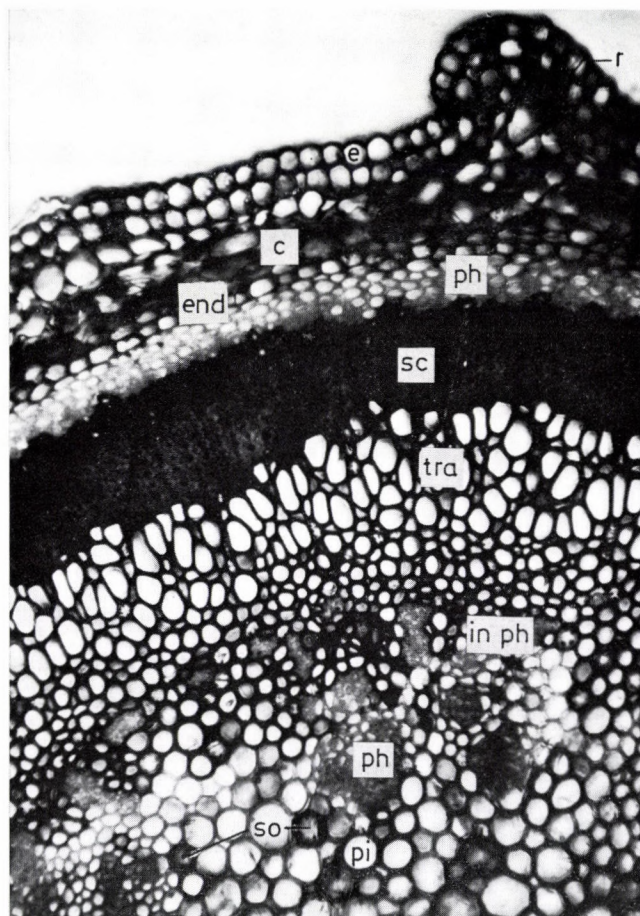
Fig. 7. Gentiana asclepiadea, 3rd internode. Cs. of stem 120×

6. Extra-, intra- or medullary- and interxylary phloems present (Figs 2, 4, 7, 10, 11). Among the three species the *G. asclepiadea* has the tallest shoots. The well developed sclerenchymatous zone may be connected with this fact. The sclerenchymatous zone of the xylem can provide the statics of the tall stem. Besides there the cell walls of the transporting zone are less thick, compared with the two other *Gentiana* species.

G. cruciata:

1. Primary cortex cells of first internode with discontionuous thickened walls (Fig. 15).
2. Xylem cylinder — consists of transporting zone only — is very thick with ray cells (Figs 21, 25). The diameter of the xylem cells increasing from the extraxylary phloem to the pith (Fig. 21).
3. The most outstanding feature is the presence of crystals, in the cork and pith (Figs 17, 18, 19).
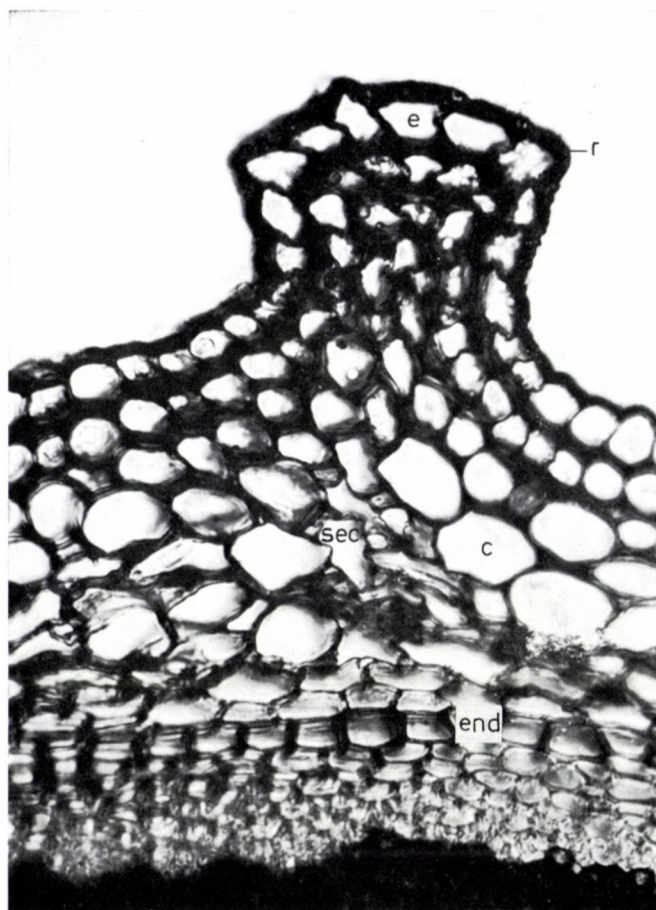
Fig. 8. Gentiana asclepiadea, 3rd internode. Showing cs prominent ribe 300×

G. pneumonanthe:

1. Papillose cells present only on ribs.
2. The tracheae are scattered in the xylem. They differ from each other in size (Fig 27).

Summary of the common characters in the three species: the diameter of the middle of the internode decreases from the first to the last, the terminal one. But the cell rows of the same tissue do not alter in the same sequence. As in the Pimpinella anisum (SZUJKÓ-LACZA 1977) also in the three *Gentiana* species the transporting zone of the xylem consists of less cell rows in the first internode than in the third one (Figs 2, 10). From the fourth one the number of the cell rows gradually decrease to the terminal internode.
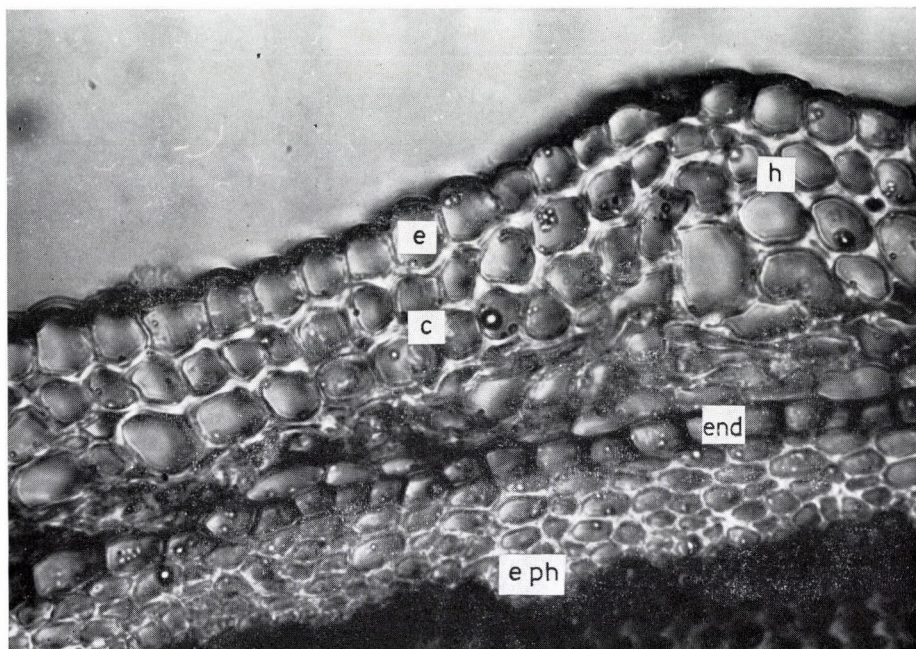
Fig. 9. Gentiana asclepiadea, 3rd internode. Cork cells with endodermis (cs) 300×

Similarity in the first internode in the three species:

The epidermal cells are intact in these developmental phases also;

Cell wall of the primary cortex cells thicken;

Endodermis, and the external- and internal phloem are present;

Scattered xylem elements are in the pith;

Dissimilarity:

The character of the cell thickening of the primary cortex cells differs that is, it is discontinuous in *G. asclepiadea* and continuous in the other two species;

The parenchyma cells are present round the tracheae in the xylem of *G. asclepiadea* and they are absent in the other two species;

The xylem consists of two distinct zones — sclerenchymatous and transporting one in *G. asclepiadea*, the *G. cruciata* and *G. pneumonanthe* have only one, the transporting zone;

Ca-oxalate crystals are in the cortex and pith parenchyma cells of *G. cruciata* only;

Similarity in the third internode:

There are more cell rows in the transporting zone along a radius than in the first internode;
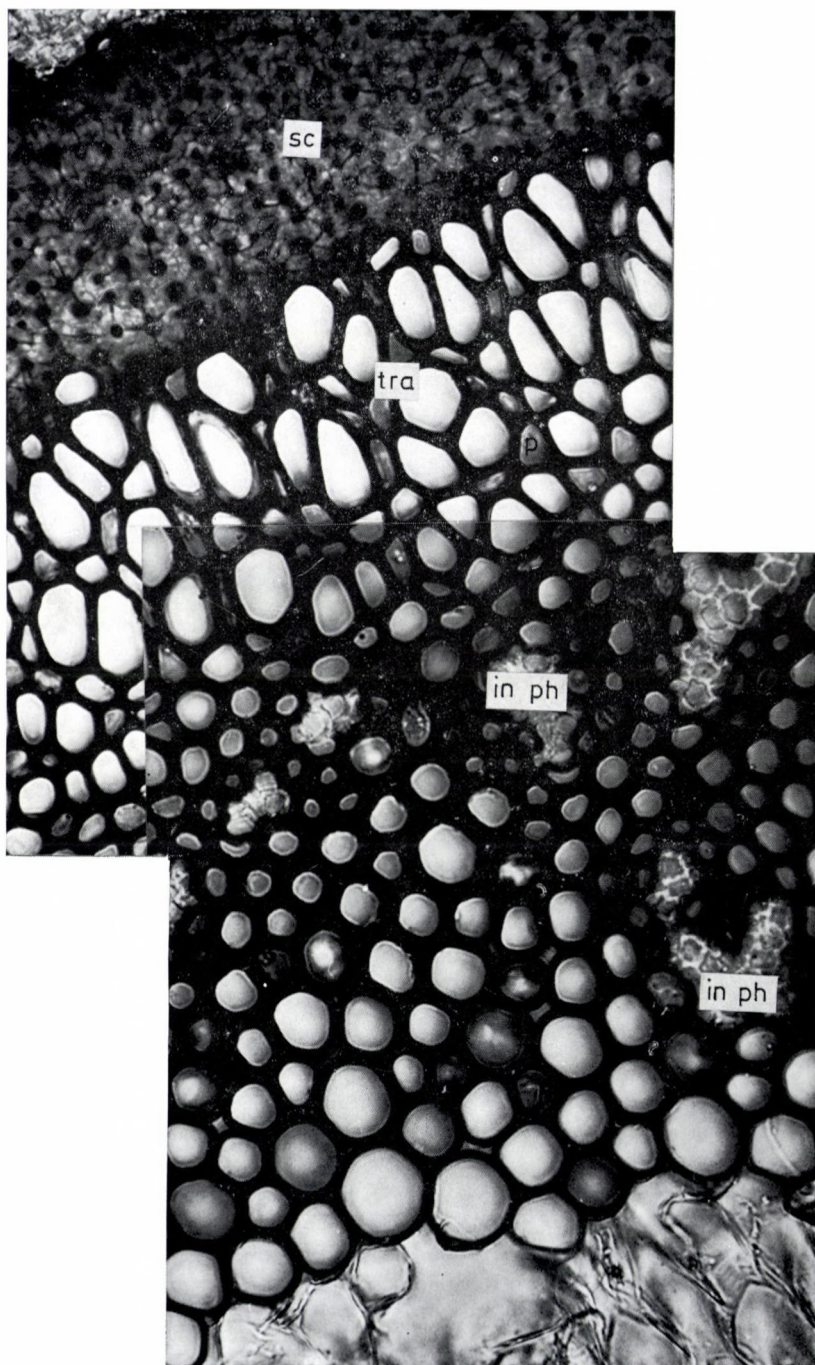
Fig. 10. Gentiana asclepiadea, 3rd internode. Sclerenchymatous cylinder in the external xylem, intraxylary phloem (cs.) 300×
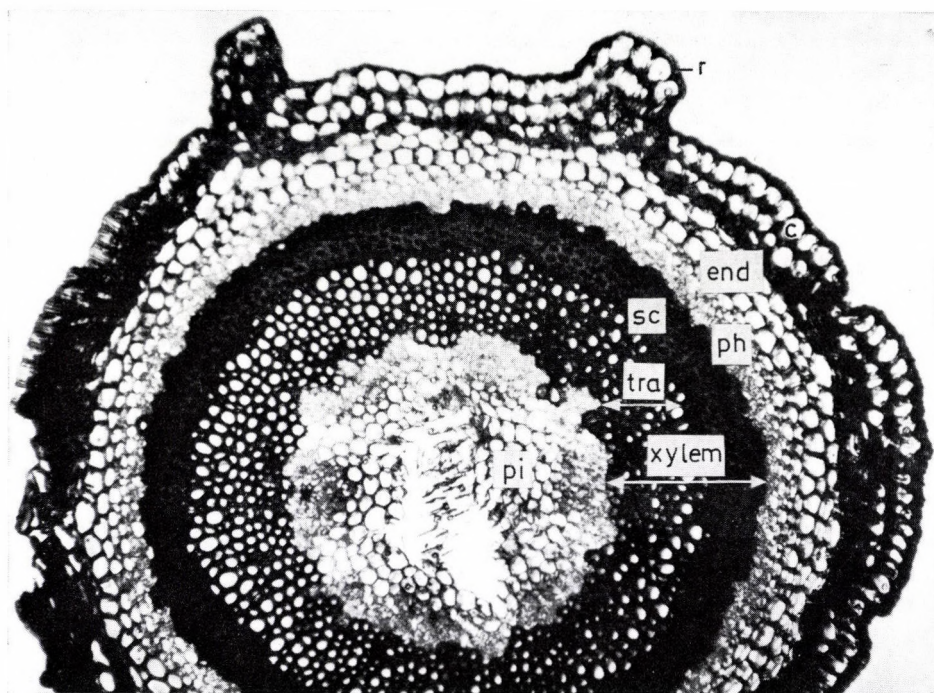
Fig. 11. Gentiana asclepiadea, terminal internode (cs.) 300×

Dissimilarity:

Under the ribs there are secretory chanels with compressed endothelial cells in *G. asclepiadea*, the other two species have mucilage cells among the cork cells. In the terminal internode compared to the third one, the similarity and dissimilarity are the same in all the three species. The differences are apparent only from the decrease of the cell number in each tissue.

Leaf anatomy:

I. Qualitative characters:

A) Common characters among three species:

1. Leaves are dorsiventral with cuticular epidermis (Figs 30, 31, 32).
2. Stomata present only on lower epidermis (Figs 32, 35).
3. Papillose cells present on leaf margin (Figs 28, 29).
4. Mesophyll differenciated into palisade and spongy tissues (Figs 30, 31, 32).
5. Mucilage cells occur in the epidermis itself and from definite but scattered cell groups immediately in the upper epidermis (Figs 30, 31, 32). The ramified extension of mucilage cells (Figs 32a, b, 38) penetrate into the intercellular spaces (Figs 31, 32). Moreover,
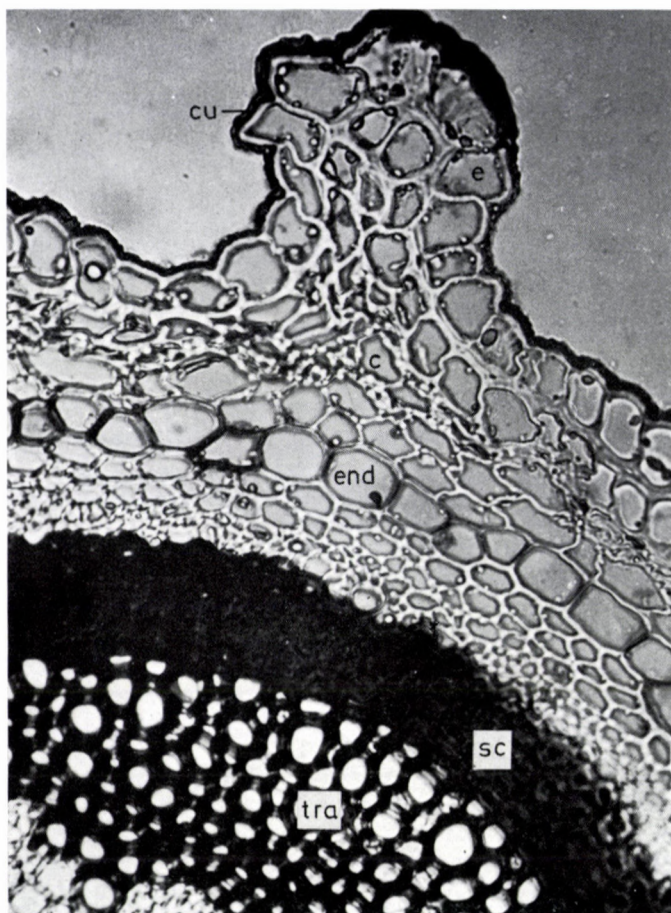
Fig. 12. Gentiana asclepiadea, terminal internode. Rib, compressed cork cells and endodermis in cs. 300×

the mucilage cells are present among the spongy parenchyma (Figs 31, 33a, 38), sometimes covering the small vascular bundles (Fig. 33b).

6. Main vascular bundles bicollateral (Figs 35, 36, 37) and smaller one collateral (Fig. 31). They are surrounded by a bundle sheath of chlorenchymatous cells (Figs 30, 31).

Common characters between the species pair respectively.

B) Similarity between two species pair respectively:

a) Characters between *G. asclepiadea* and *G. cruciata*: There is no character which is common only to these species.

b) Characters between *G. asclepiadea* and *G. pneumonanthe*: The parenchymatous tissue just below the main vascular bundle raise out on the under side of the leaf (Figs. 36, 37).

c) Characters between *G. cruciata* and *G. pneumonanthe*: The palisade tissue (one or two rows) and transitional cells are well-developed (Figs 31, 32).
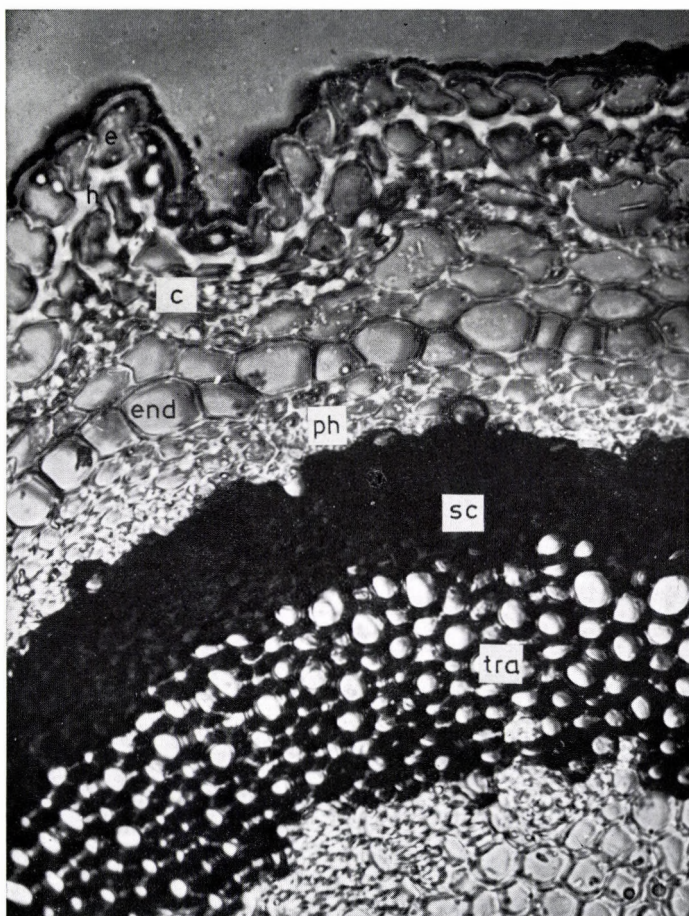
Fig. 13. Gentiana asclepiadea, terminal internode. Hypodermis under compressed cork cells and endodermis. Extraxylary phloem and xylem (cs.) 300×

C) Diagnostic characters:

G. asclepiadea:

1. The main vascular bundle and two lateral bundles arise out on the under side (Fig. 36).
2. Palisade tissue two-layered with smaller cells (Fig. 30).
3. Upper epidermis wavy in outline (Fig. 30).

G. cruciata:

1. The vascular bundles do not bulge out (Fig. 35).
2. Upper epidermal cells wavy in outline only in the regions of main vascular bundle and big lateral bundle (Fig. 35).
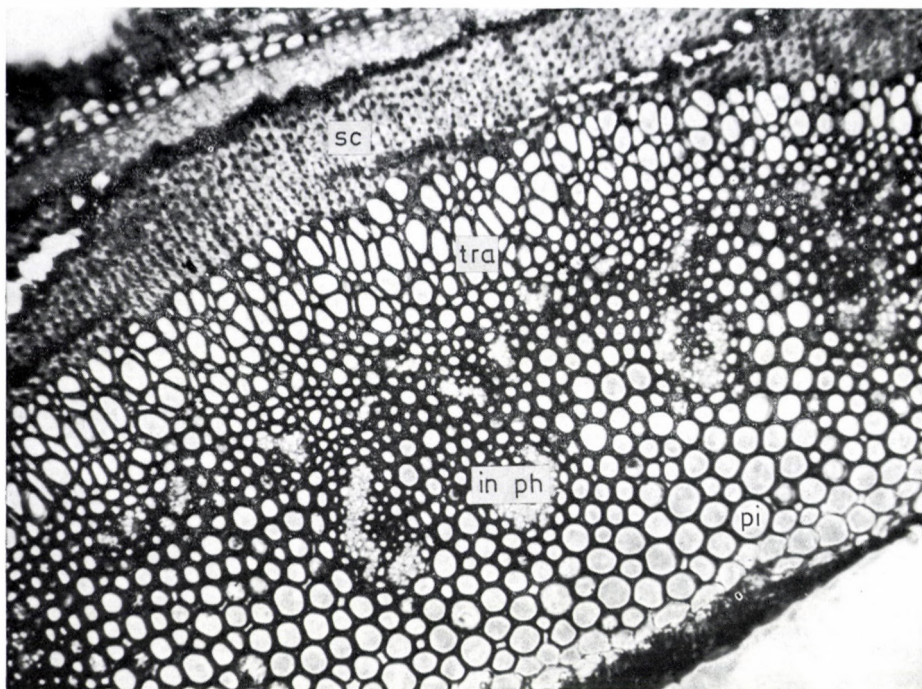
Fig. 14. Gentiana asclepiadea, terminal internode. Narrow cylindrical sclerenchyma is in xylem and scattered interxylary phloem 120×

G. pneumonanthe:

1. Only main vascular bundle bulge out on under side (Fig. 37).
2. Epidermal cells not wavy but stright in outline.
3. The whole mesophyll is more completely mucilaginous, including transitional cells (Fig. 32).

II. Quantitative characters:

Table 1 represents the values of the different anatomical quantitative characters of three *Gentiana* species. It may be noted in these basic data that among the three species *G. cruciata* has maximum mean values for the character number c_1, c_2, c_6, c_8 and c_9. Ecologically this is quite expected because as pointed out by us (SZUJKÓ-LACZA and SEN 1977c) this species grows maximally in forest felling (frequency value 0.87) and dry mountain grass land (frequency value 0.59). *G. asclepiadea* shows maximum mean values for characters c_5 and c_7. This is also due to its ecological characteristics. It grows mainly in areas of over 800 mm annual rainfall. In case of *G. pneumonanthe* the maximum mean values are noted by character number c_3 and c_4. It is possible that the

Table 1

Values of anatomical characters of leaves in three Gentiana species

Serial No. Name of the species	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8	c_9
G. pneumonanthe	4.235000	4.201637	25	35	0.7058	28338	5024	159725	31550
	4.089750	4.050500	30	32	0.6816	31400	7850	216911	49298
	4.368000	4.330241	28	34	0.6240	31400	6358	195220	62115
×	4.230916	4.194126	27.67	32.33	0.6715	30379	6410.67	190618.18	47654.40
G. cruciata	11.625000	11.481738	18	24	0.6458	125600	17662	473260	118315
	10.713600	10.570338	16	21	0.6302	131958	11304	768062	106483
	12.909000	12.757260	17	25	0.7172	138474	13266	993847	76904
×	11.749200	11.603112	17.00	23.33	0.6638	132010	14077.33	745057.00	100567.33
G. asclepiadea	5.286500	5.193556	14	13	0.5874	61544	31400	331282	116911
	5.558100	5.495415	18	14	0.6948	90746	28338	335226	93666
	5.614500	5.518416	17	12	0.9358	70650	25434	414103	88736
×	5.486366	5.402462	16.33	13.00	0.7125	74313	28390.16	360204.00	99771.26

c_1 = Anatomical characters of leaves studied in C.S.
c_1 = Area of half leaf (in μm^2); c_2 = Area of mesophyll tissue and secondary vascular bundles (μm^2); c_3 = Number of stomata in a quadrate (lower side of the leaf); c_4 = Total number of papillose cells in a quadrate; c_5 = Number of vascular bundle per unit area of leaf; c_6 = Area of main vascular bundle (μm^2); c_7 = Area of 1st lateral vascular bundle (μm^2); c_8 = Area of bundle sheath parenchyma in main vascular bundle (μm^2); c_9 = Area of bundle sheath parenchyma in 1st lateral vascular bundle (μm^2).
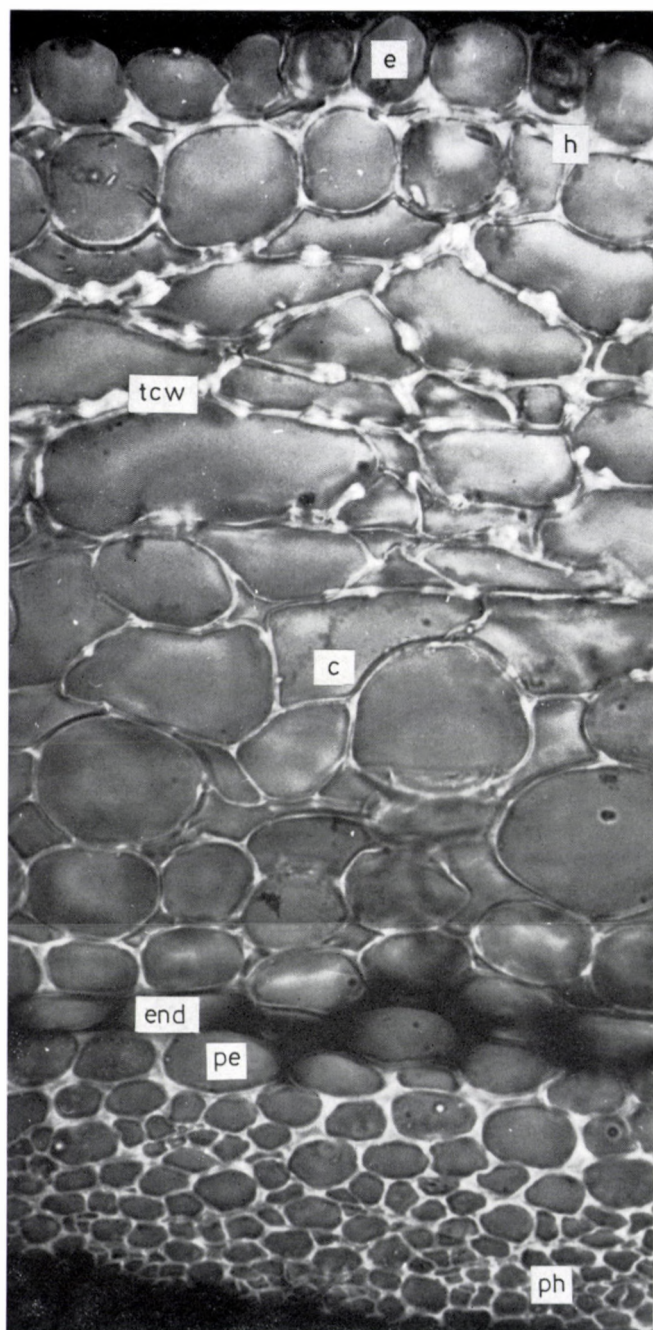
Fig. 15. Gentiana cruciata, 1st internode. Cs of cork cells with special thickening of cell walls 300×

Fig. 16. Gentiana cruciata, 1st internode Ts. of endodermis and pericycle 750×

Table 2

Total number of papillose cells in a quadrate/species

No. of observations	1	2	3	4	5	Average
Name of the species						
G. pneumonanthe	31	32	34	30	35	32.4
G. cruciata	24	21	25	22	21	22.6
G. asclepiadea	13	14	12	14	13	13.2

Table 3

Analysis of variance in total number of papillose cells in a quadrate

Sources of variability	SQ	FG	MQ	F
Treatment	921.73	2	460.87	166.4
Residual	33.20	12	2.77	—
Total	954.93	14	—	—
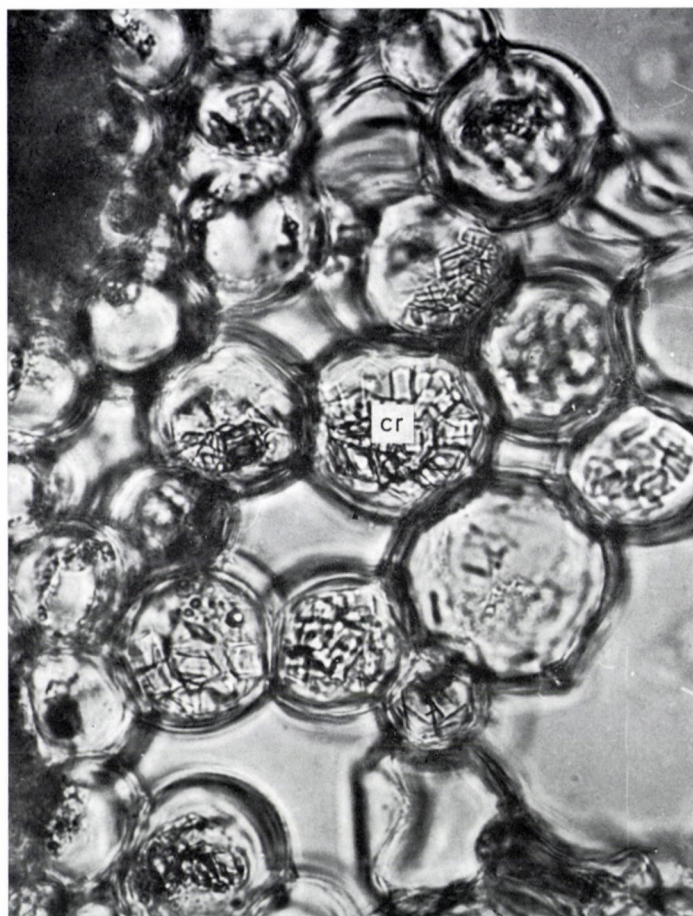
Fig. 17. Gentiana cruciata, 1st internode. Crystals in pith parenchyma cells 300×

Table 4

Average (in the diagonal), their differences (in the right upper half of the matrix) indicate significances

Species	1	2	3
G. pneumonanthe	32.4	—	—
G. cruciata	*	22.6	—
G. asclepiadea	**	*	13.2
$SD_{5\%} = 2.29$			

* P > 5%; ** P > 1%

number of stomata per square is related to ecological and species factors also. This species is generally available in highly illuminated areas and marshy lands.
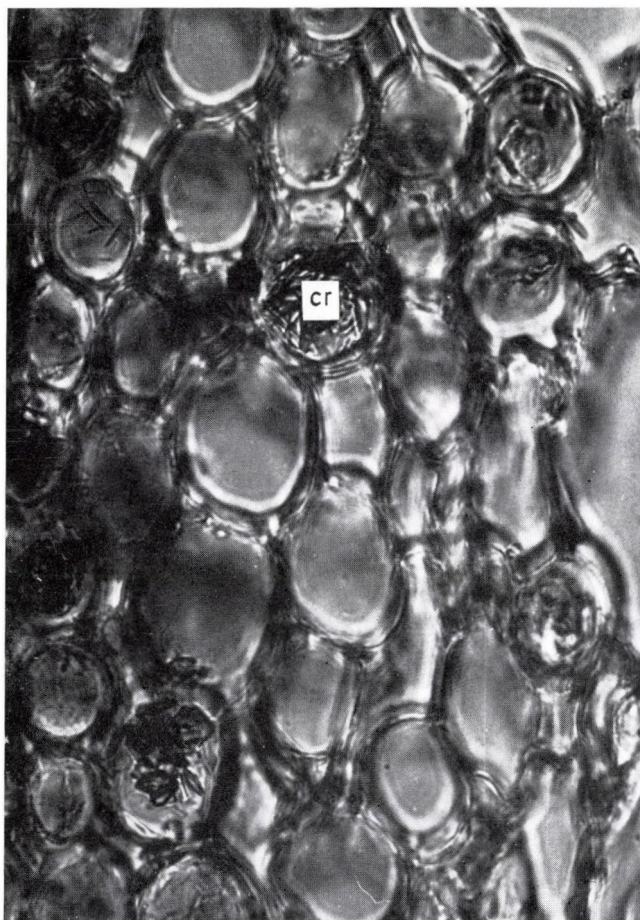
Fig. 18. Gentiana cruciata, 1st internode. Crystals in the cork cells 300×

We do not know the function of papillose cells. The number of papillose cells in a square may or may not be associated with any ecological factor.

The distribution of papillose cells per quadrate (on the leaf margin) is given in Table 4. This character appears to have considerable anatomical and taxonomic values because the analysis of this character shows significant differences among the three species. *G. pneumonanthe* has many more papillose cells per square and *G. asclepiadea* has less.
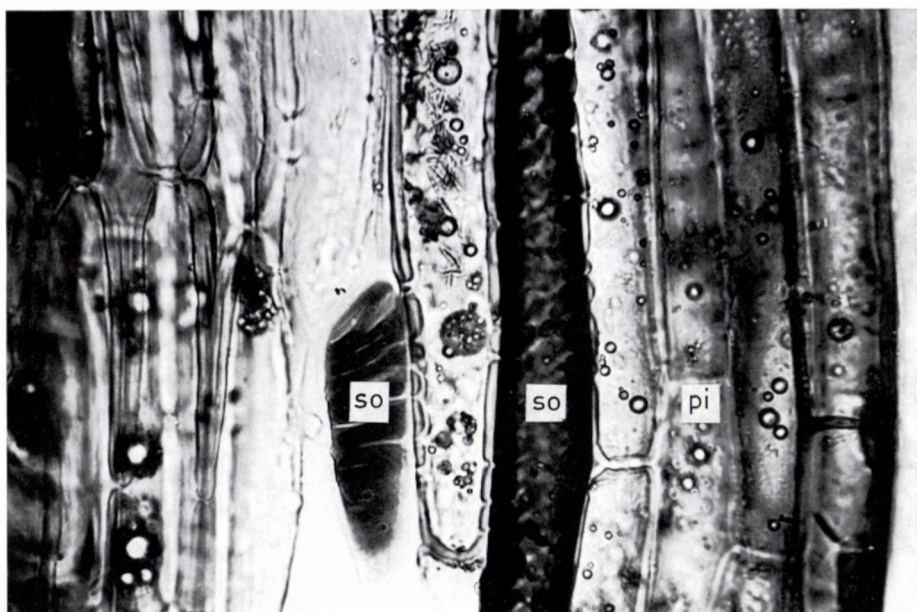
Fig. 19. Gentiana cruciata, 1st internode. Ts. of scattered xylem element in pith 300×
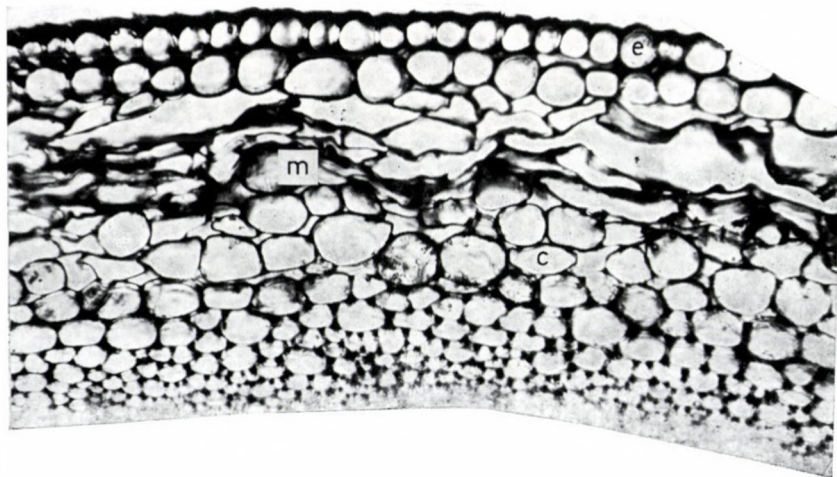
Fig. 20. Gentiana cruciata, 3rd internode. Cs. of stem 120×

The number of stomata has been counted in two ways (Tables 5 and 8), number of stomata in 0.68 mm^2 of epidermal peels with five repetitions and the number of stomata along the cross-sections. Significant differences between the three species are to be found in the number of stomata per square but
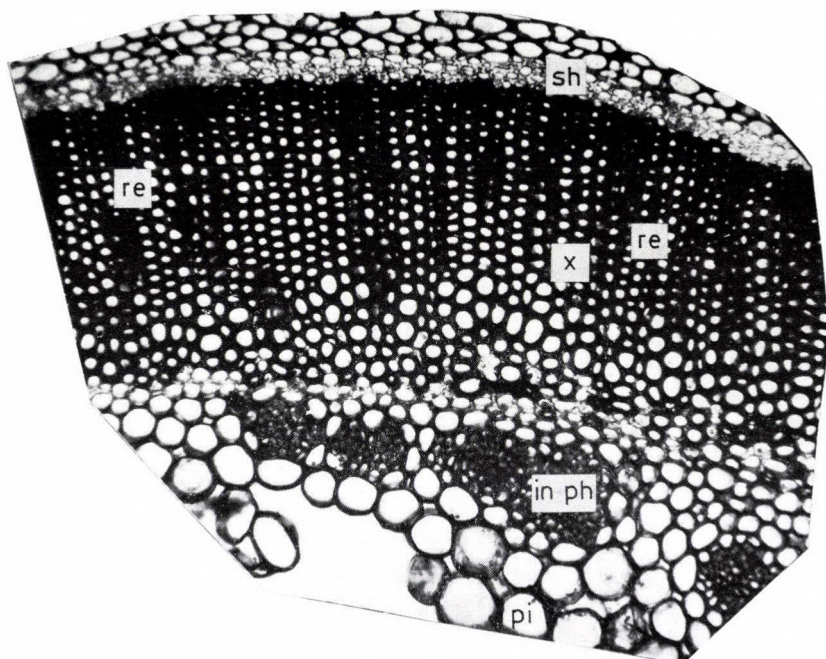
Fig. 21. Gentiana cruciata, 3rd internode. Cs. of stem 120×
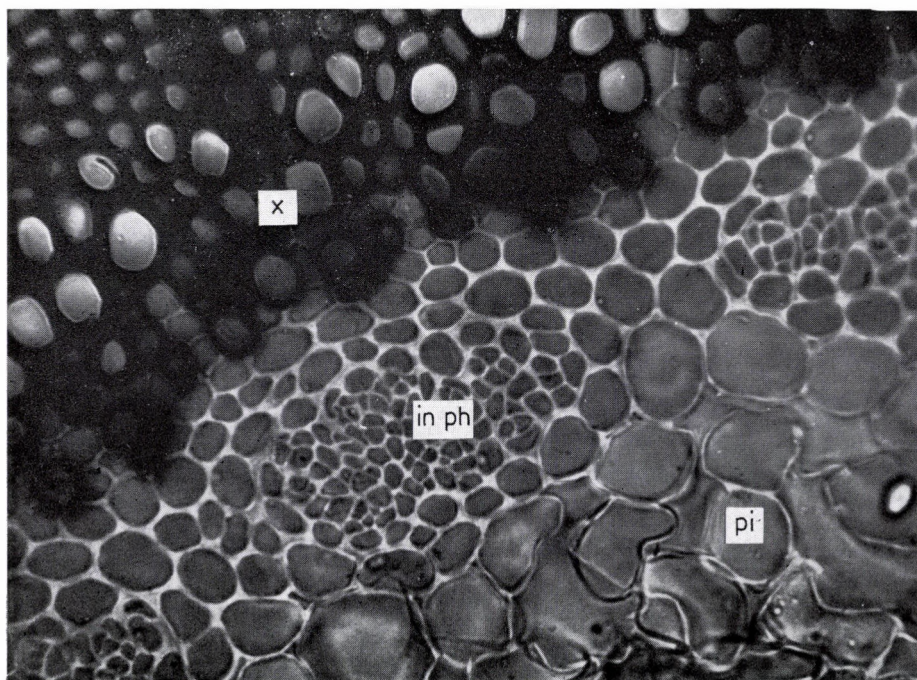
Fig. 22. Gentiana cruciata, 3rd internode. Inner phloem (cs.) 750×
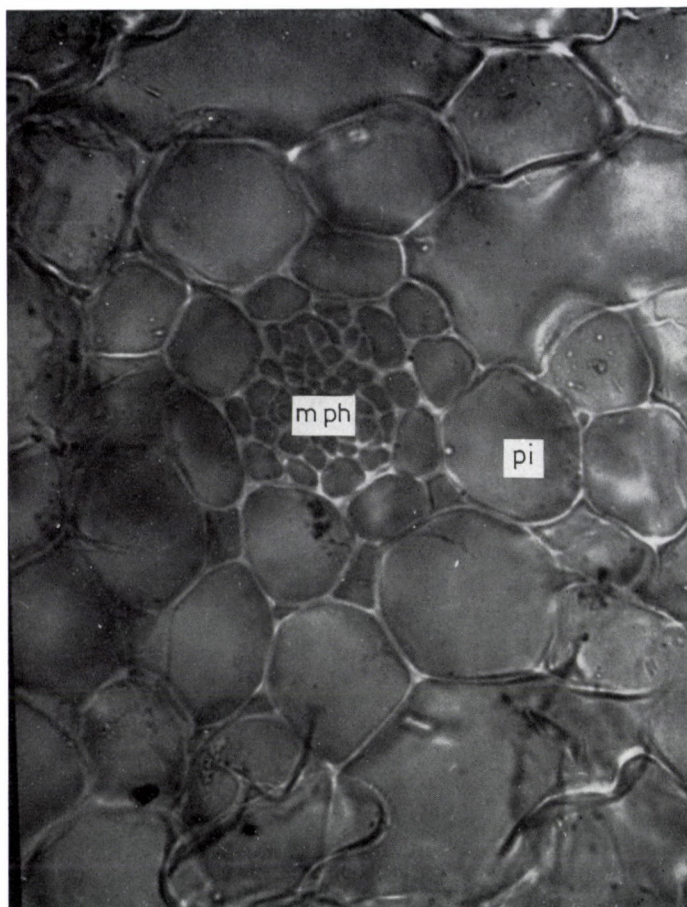
Fig. 23. Gentiana cruciata, 3rd internode. Medullary phloem (cs.) 750×

Table 5

Total number of stomata in a quadrate/species

No. of observations	1	2	3	4	5	Average
Name of the species						
G. pneumonanthe	25	30	28	29	34	29.2
G. cruciata	18	16	17	19	14	16.8
G. asclepiadea	14	18	17	14	16	15.8
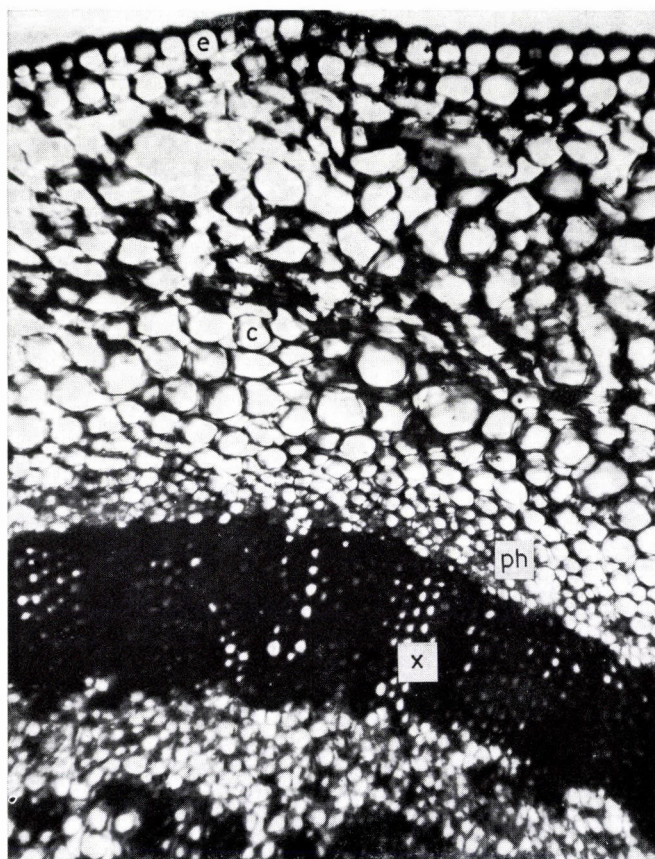
Fig. 24. Gentiana cruciata, terminal internode. Cs. of stem 120×

Table 6

Analysis of variance in total number of stomata in a quadrate

Sources of variability	SA	FG	MQ	F
Treatment	557.2	2	278.60	47.46
Residual	70.4	12	5.87	—
Total	627.6	14	—	—

when the sample was taken in the cross-section have not S.D. in analysis of variance (Tables 11, 12, 13).

With respect to the thickness of palisade parenchyma (Table 13) ***G. asclepiadea*** differs from the other two species significantly also in (Figs 30, 31, 32).
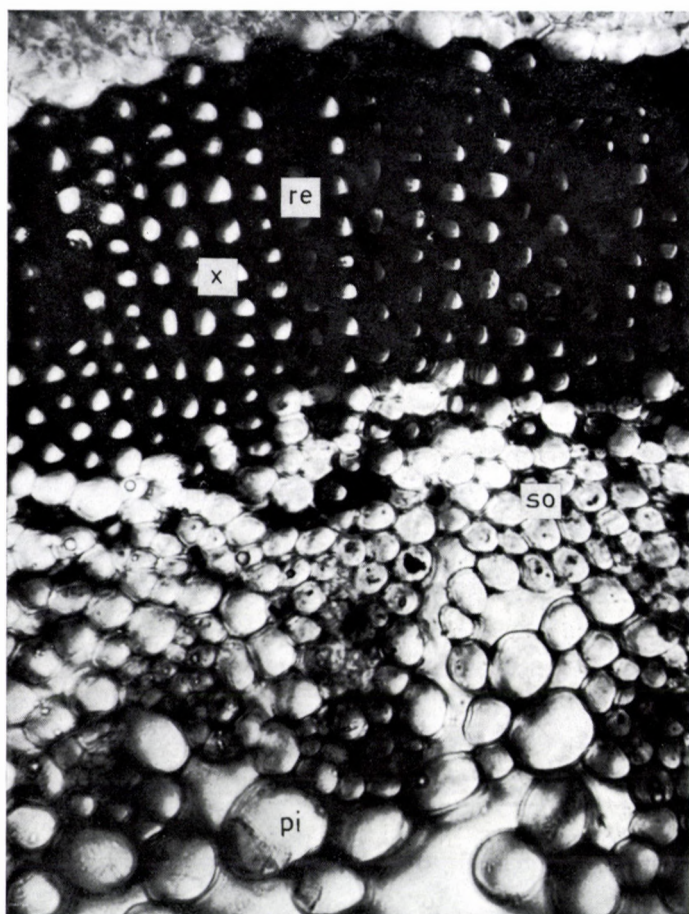
Fig. 25. Gentiana cruciata, terminal internode. Xylem with rays (cs.) 750×

Table 7

Average (in the diagonal), their differences (in the right upper half of the matrix) indicate significance

Species	1	2	3
G. pneumonanthe	29.2	—	—
G. cruciata	*	16.8	—
G. asclepiadea	**	—	15.8
$SD_{5\%} = 3.33$			

* P > 5%; ** P > 1%
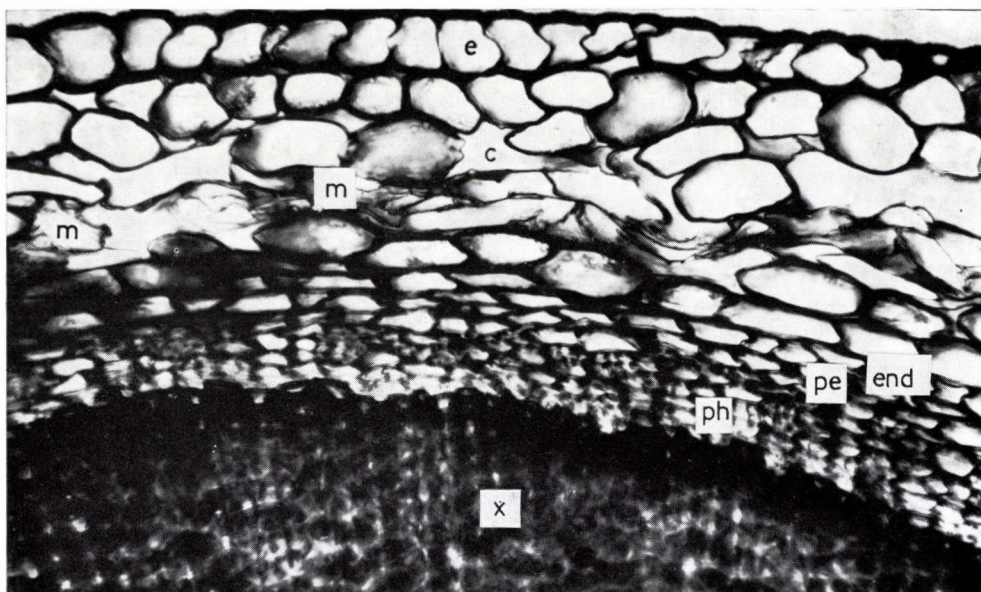
Fig. 26. Gentiana pneumonanthe, Cs. of stem in 3rd internode 300×

Table 8

Number of stomata in lower side of the half-leaf/species

No. of observations	1	2	3	Average
G. pneumonanthe	11	12	12	11.66
G. cruciata	15	14	17	15.33
G. asclepiadea	18	10	11	13.00

Table 9

Analysis of variance in total number of stomata in lower side of the half-leaf

Sources of variability	SQ	FG	MQ	F
Treatment	20.67	2	10.34	1.43
Residual	43.33	6	7.22	—
Total	64.00	8	—	—
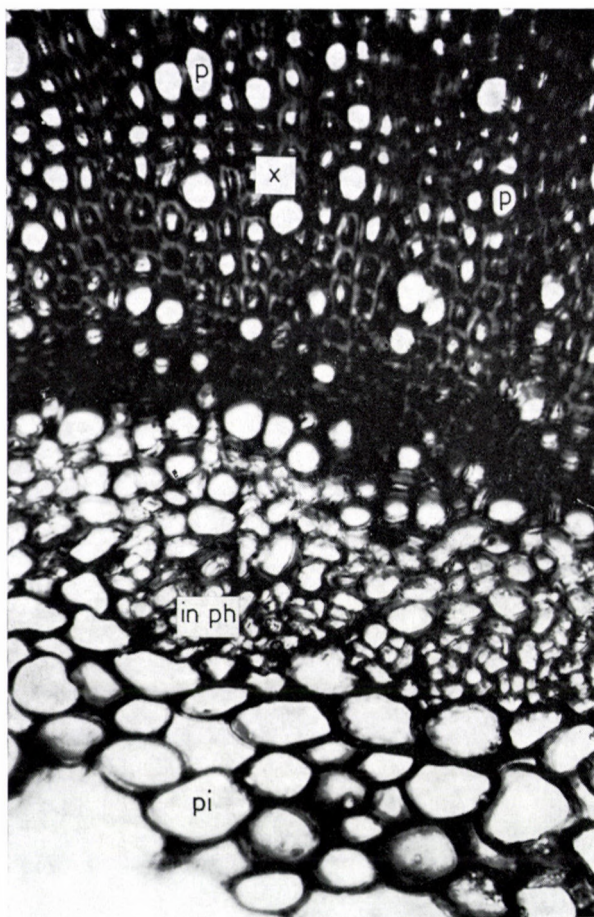
Fig. 27. Gentiana pneumonanthe, Cs. of stem in 1st internode 300×

Table 10

Average (in the diagonal), their differences (in the right upper half of the matrix) indicate no significance

Species	1	2	3
G. pneumonanthe	11.66	—	—
G. cruciata	—	15.33	—
G. asclepiadea	—	—	13
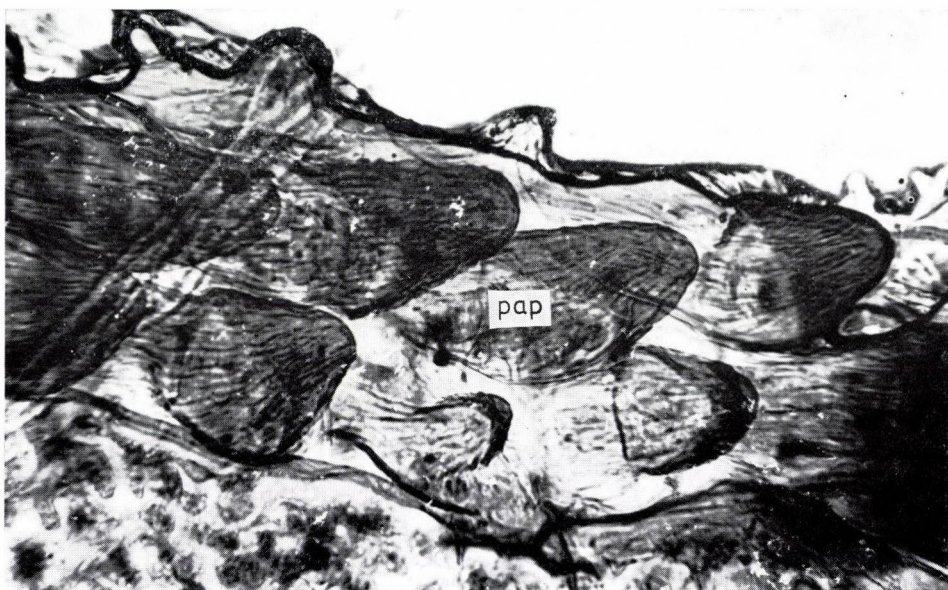
Fig. 28. Papillose cells on the leaf margin of *G. asclepiadea* 300×
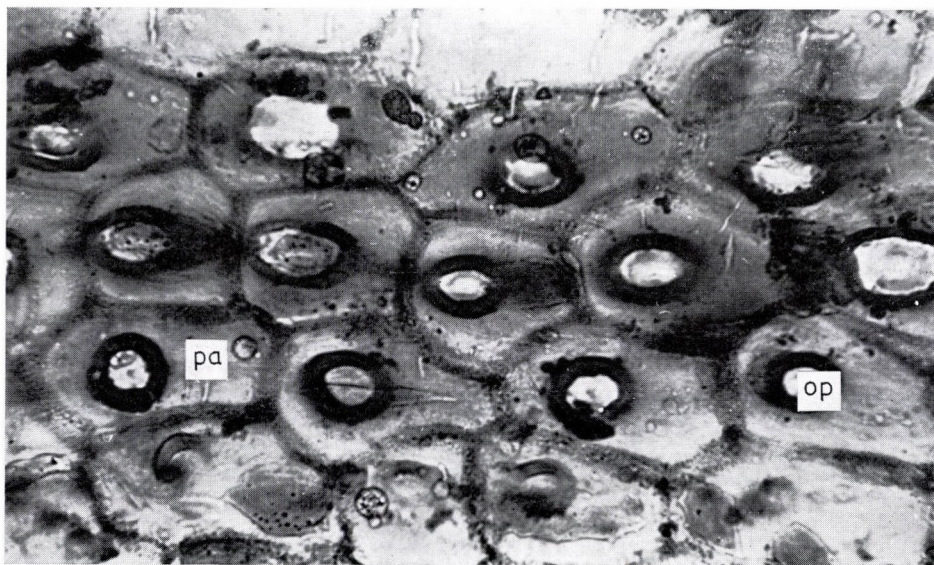
Fig. 29. Papillose cells from the inner side of epidermis cells (*G. asclepiadea*). Basis of papilla ovate or round in form 300×
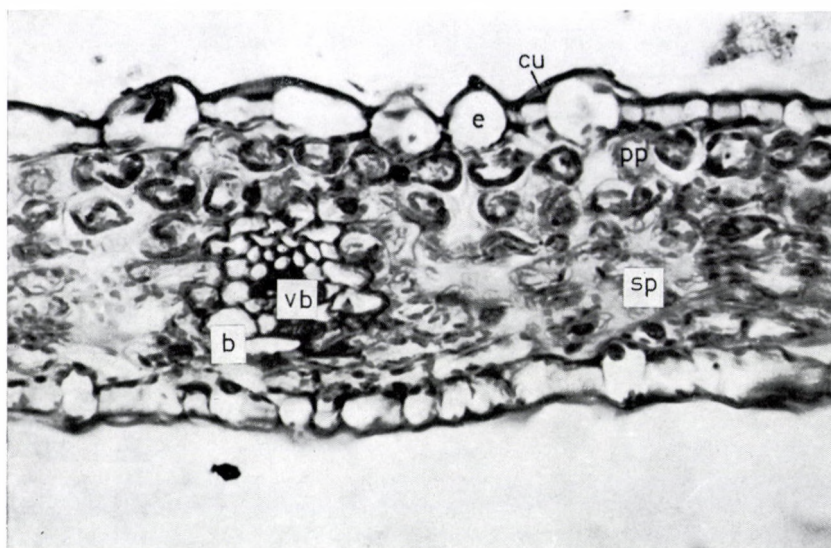
Fig. 30. Leaf cs. in *Gentiana asclepiadea*, 120×

Table 11

Thickness of palisade parenchyma/species

No. of observations	1	2	3	Average
Name of the species				
G. pneumonanthe	170	150	140	153.33
G. cruciata	150	140	200	163.33
G. asclepiadea	70	70	70	70.00

Table 12

Analysis of variance in thickness of palisade parenchyma

Sources of variability	SQ	FG	MQ	F
Treatment	15755.55	2	7877.78	18.65
Residual	2533.34	6	422.22	—
Total	18288.89	8	—	—
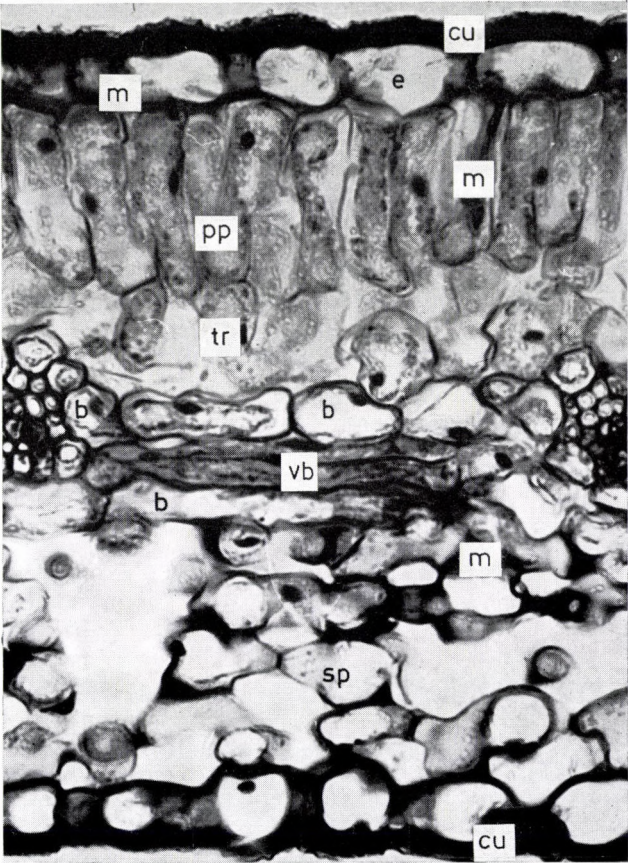
Fig. 31. Leaf cs. in *Gentiana cruciata*, 300×

Table 13

Average (in the diagonal), their differences (in the right upper half of the matrix) indicate significance

Species	1	2	3
G. pneumonanthe	153.33	—	—
G. cruciata	—	163.33	—
G. asclepiadea	*	*	70
$SD_{5\%} = 41.09$			

* $P > 5\%$; ** $P > 1\%$
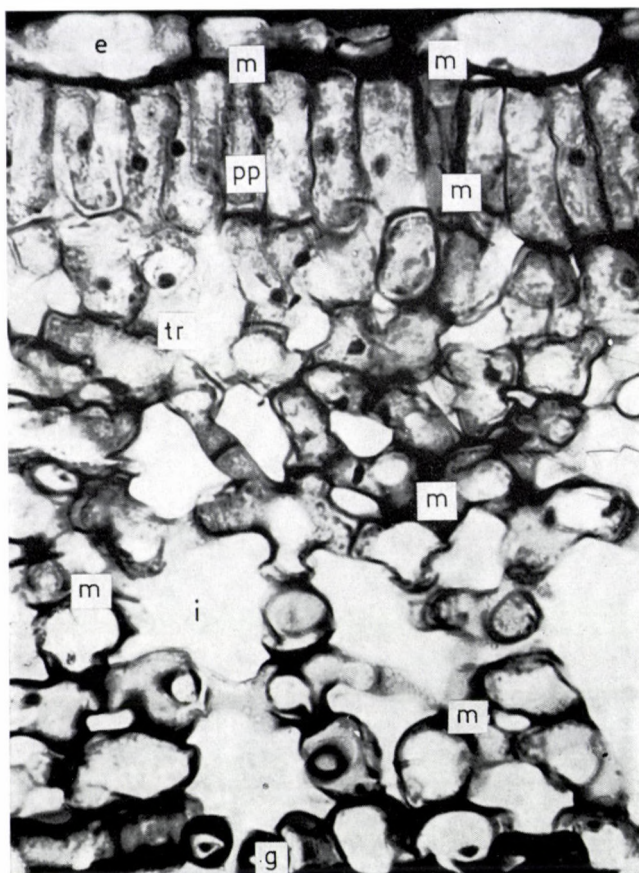
Fig. 32. Leaf cs. in *Gentiana pneumonanthe*, 300×

Table 14

The r values between different character pairs of leaves in three Gentiana species

Character No.	*G. pneumonanthe*	*G. cruciata*	*G. asclepiadea*
2 and 3	0.8401	0.8121	−0.1295
4 and 5	0.8474	0.9966***	−0.1526
6 and 7	0.4808	0.4771	0.9423*
1 and 8	−0.1871	0.3668	0.8031
8 and 9	−0.7228	0.5536	0.1670
8 and 10	0.4329	0.7211	0.2401

* P > 5%: *** P > 1%

1. Area of half-leaf
2. Area of mesophyll cells and secondary vascular bundles
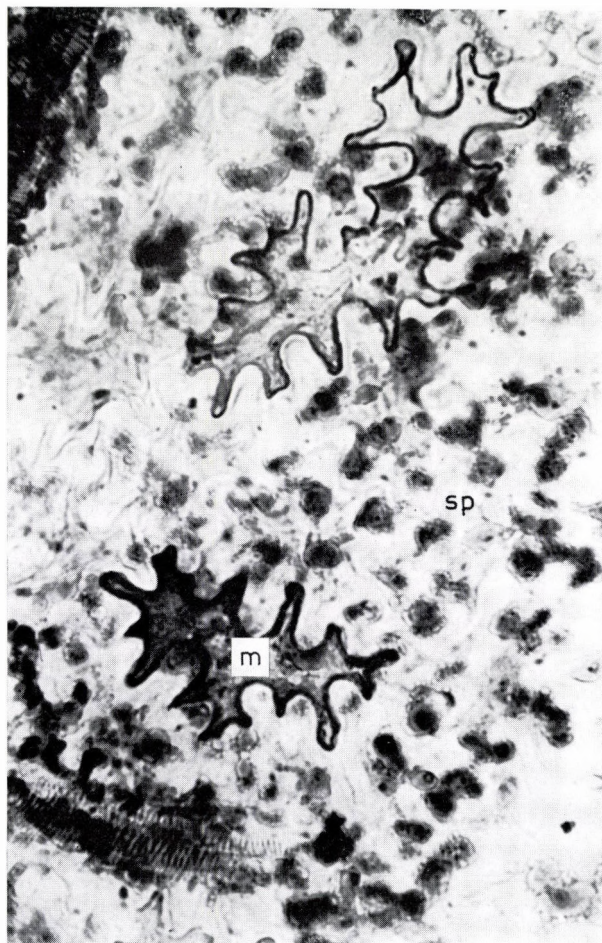
Fig. 33a, b. Mucilage cells with spongy parenchyma in *G. asclepiadea*, paradermal preparation 300×

3. Number of vascular bundles
4. Area of main vascular bundle
5. Area of bundle sheath parenchyma of main vascular bundle
6. Area of 1st lateral vascular bundle
7. Area of bundle sheath parenchyma of 1st lateral vascular bundle
8. Number of stomata in a quadrate
9. Number of vascular bundle per unit area of leaf
10. Number of papillose cells in a quadrate

In Table 14 the correlation coefficient was determined between 10 selected character pairs. In *G. cruciata* significant values could be found only in character pairs 4 and 5 and *G. asclepiadea* shows significant correlation only

between character number 6 and 7 i.e. the area of main vascular bundle or 1st lateral bundle and bundle sheath parenchyma respectively.

The length of the stomate shows higher diversity values than the breadth (Table 15). The length of the stomata shows maximum diversity in *G. cruciata*
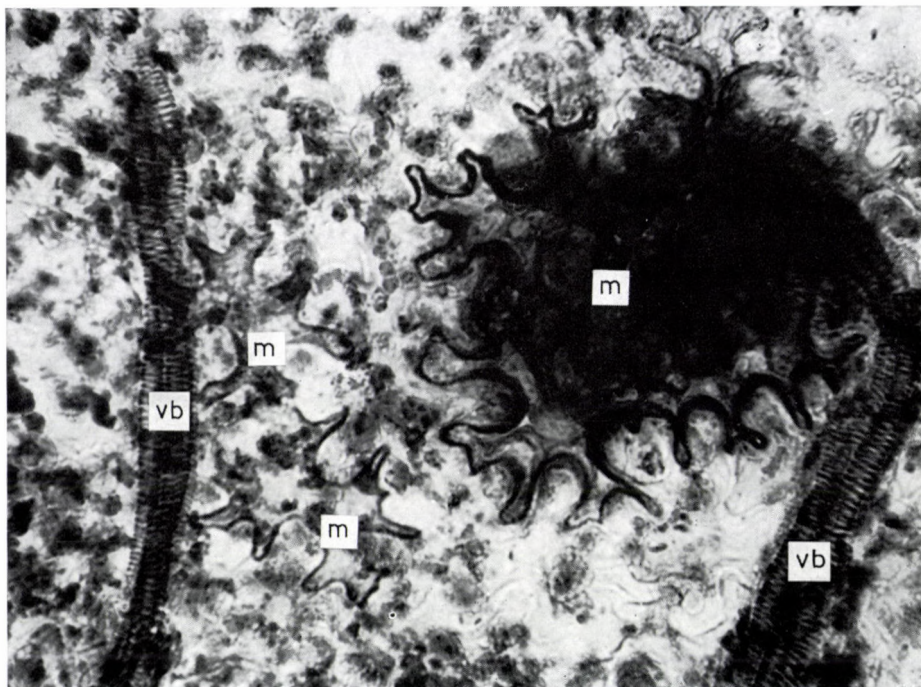
Fig. 33b

while the remaining species have more or less similar diversity. With respect to the breadth of stomata a minimum diversity is noted in *G. cruciata*.

The number of stomata in a square does not show any variation in its diversity values among the three species (Table 15). This reinforces the results of analysis of variance (Table 8) with respect to the S.D. in the number of stomata per square between the species.

As noted in Table 15, the papillose cells per square show high diversity but high equitability values in *G. cruciata*. The other two species are more or less similar to each other with respect to the diversity and equitability of the number of papillose cells per square.
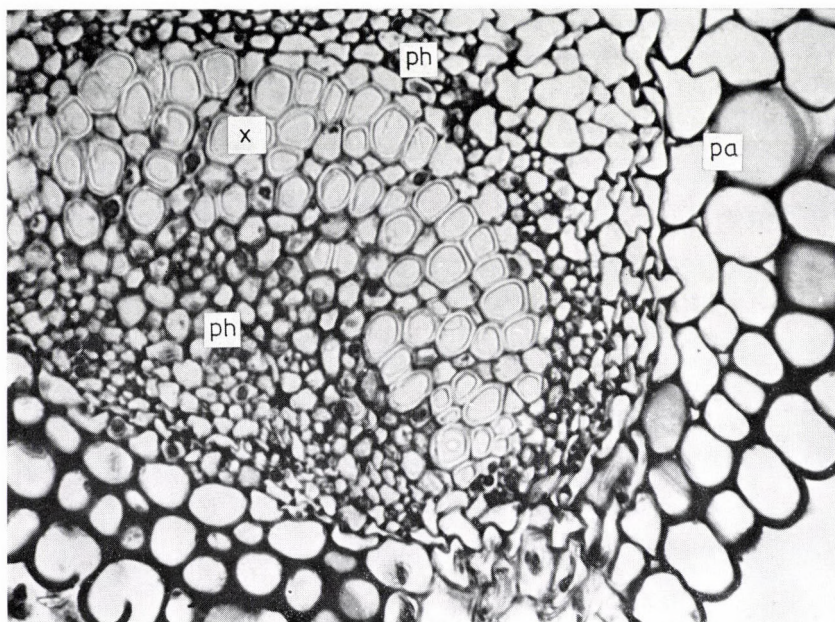
Fig. 34. Bicollateral main vein in *G. cruciata*, (cs.) 300×
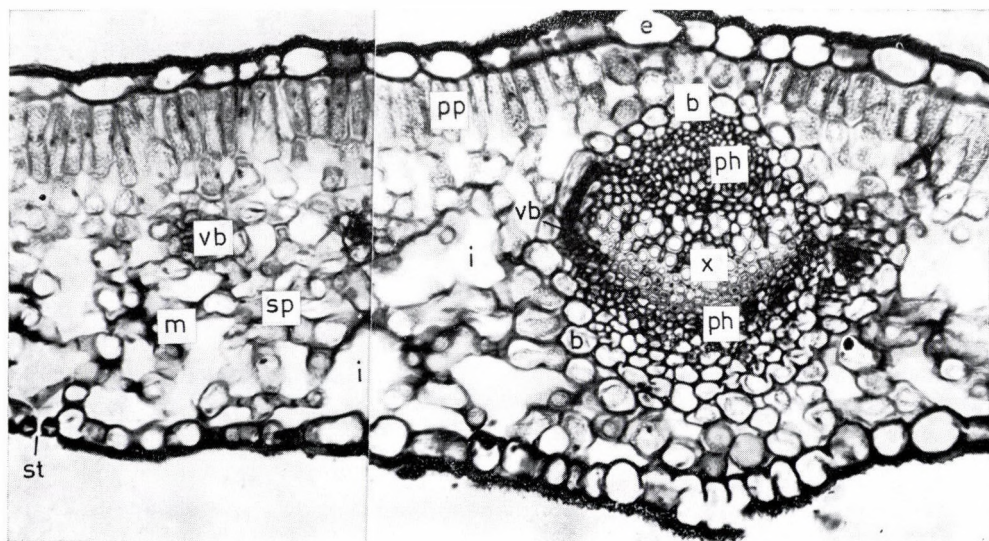
Fig. 35. First ordered bicollateral vascular bundle in *G. cruciata*, (cs.) 120×
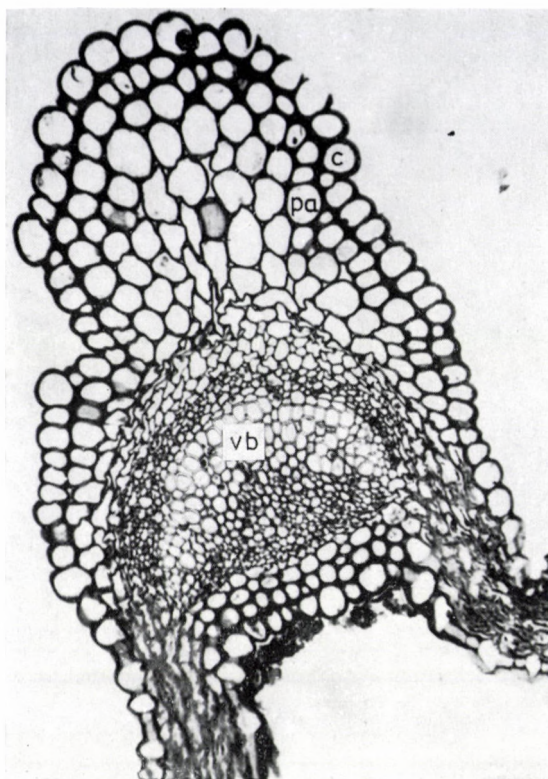
Fig. 36. Main vascular bundle in *G. asclepiadea*, 120×

Table 15

Diversity (H') and evenness (E) values of three leaf characters in three Gentiana species

Name of the species	*G. pneumonanthe*		*G. cruciata*		*G. asclepiadea*	
	H'	E	H'	E	H'	E
The length and breadth of stomata						
L	1.0964	0.7909	1.3040	0.9406	1.0963	0.7908
B	0.8451	0.7693	0.5076	0.3661	0.7232	0.6583
Stomata in a quadrate	1.6037	0.9964	1.6040	0.9966	1.6038	0.9965
Papillose cells in a quadrate	1.2874	0.7999	1.6068	0.9984	1.3739	0.8537

* 1 — length and B = breadth
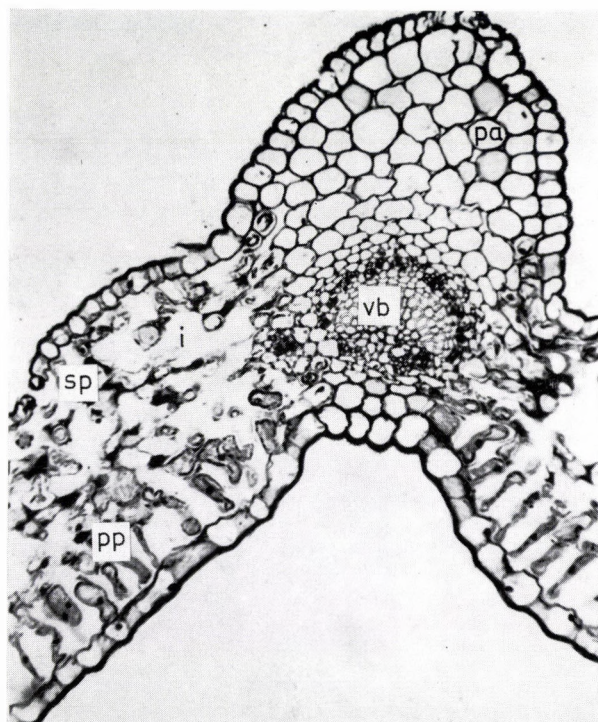
Fig. 37. Main vascular bundle in *G. pneumonanthe*, 120×
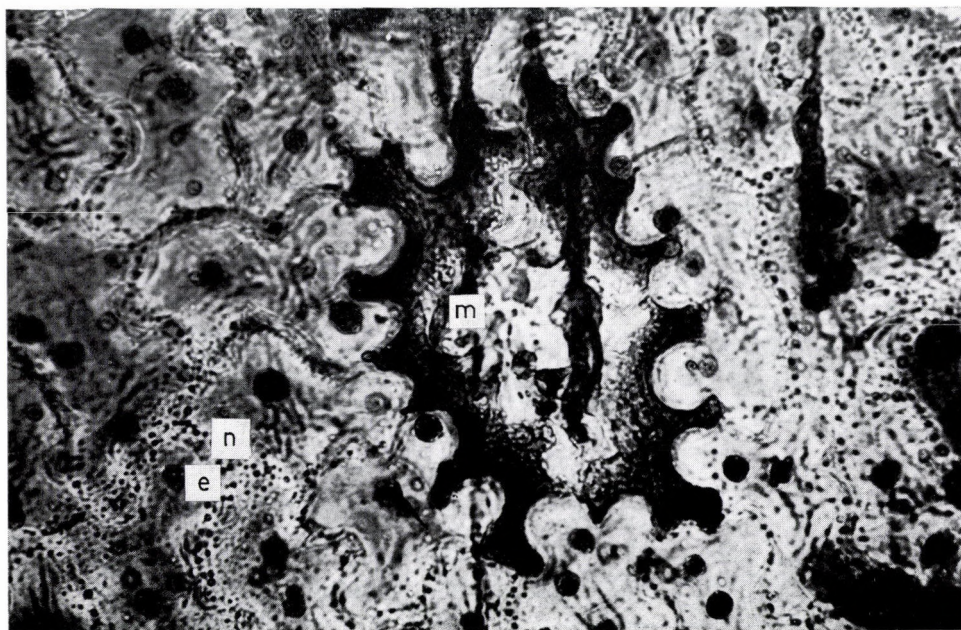
Fig. 38. Epidermal mucilage cells in *G. pneumonanthe*. Paradermal preparation 300×

Conclusion

There are five anatomical characters of the stem and six of the leaf which are common to the three species of Hungarian *Gentiana*.

In stem anatomy *G. cruciata* and *G. pneumonanthe* appears to be more closer to each other than either of them to *G. asclepiadea*.

From the point of view of diagnosis there appear to be 4 stem characters (*viz.* the presence of secretory canals and endothelial cells in primary cortex; in the xylem the fibrous sclerenchyma forming a close cylinder without ray cells; the presence of intra xylary phloem; and the three leaf characters) i.e. bulging out of the main vascular bundle and the two lateral bundles on the lower side; two-layered palisade tissue with smaller cells; wavy outline of upper epidermis; the lower values of the papillose cells in a square on the leaf margin which are characteristic of *G. asclepiadea*.

G. cruciata can easily be separated from the other two species by 2 stem characters (i.e. discontinuously thickened primary cortex cells of first internode; presence of crystals in the cork and pith parenchyma; and 2 leaf characters (i.e. vascular bundles not bulging out with mesophyll tissue); upper epidermis wavy in outline only in main vascular bundle and big lateral bundle regions).

There are two stem (i.e. presence of papillose cells on ribs; the different size of pores in the xylem); and 2 leaf characters (i.e. only main vascular bundle bulging out with mesophyll parenchyma on lower side; epidermal cells not wavy but straight in outline which can be used for identification of *G. pneumonanthe*.

Quantitatively the species pair *G. asclepiadea* and *G. cruciata* in the leaf is not similar. *G. asclepiadea*—*G. pneumonanthe* and *G. cruciata*—*G. pneumonanthe* have one common character respectively. The three species significantly differ from each other in the number of papillose cells and the number of stomata per square, and *G. asclepiadea* from the other two in the thickness of palisade parenchyma. There is a significant correlation in *G. cruciata* and *G. pneumonanthe* with respect to the area of the main or 1st lateral bundle and bundle sheath parenchyma. These two species usually grow in a well-illuminated area. Therefore we can suppose, there may be some connection between the well-developed bundle sheath parenchyma and some sort of environmental factor(s).

It is evident from our present and previous studies that both anatomical and morphological characters show a similar pattern of relationship among the three species of *Gentiana*. So, these features taken together may be very useful for the diagnosis of the three species. It may be pointed out that both of these features support the present taxonomic treatment of these taxa.

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REFERENCES

ESAU, K. (1969): Pflanzenanatomie. pp. 372—373. Veb. Gustav Fischer Verlag Jena.

GOPAL KRISHNA, G.—PURI, V. (1962): Morphology of the flower of some *Gentianaceae* with special reference to placentation. Bot. Gaz., **124**, 42—57.

GULATI, N. (1967): *Gentianaceae*. Seminar on comparative embryology of angiosperm. pp. 89—90.

HEGI, G. (1906): Illustrierte Flora von Mittel-Europa. V/3. 1953—2047.

KAUSSMANN, B. (1963): Pflanzenanatomie. pp. 446—447. Veb. Gustav Fischer Verlag Jena.

KSHETRAPAL, S. (1969): Structure and evolution of the gynoecium in *Gentianales*. Seminar on Morphology Anatomy and Embryology of land plants. 39—40.

KÜSTER, E. (1956): Die Pflanzenzelle. pp. 854—855. Veb. Gustav Fischer Verlag Jena.

METCALFE, C. R.—CHALK, L. (1965): Anatomy of the dicotyledons. **2**, 933—936. Clarendon press, London.

PIELOU, E. C. (1975): Ecological diversity. Wiley, New York—Toronto.

SHANNON, C. E. (1948): The mathematical theory of communication. Bull. Syst. Techn. J. **27**, 379—423. 623—656.

SVÁB, J. (1976): Biometriai módszerek a mezőgazdasági kutatásban (Biometrical methods in agricultural research). Budapest, pp. 499. Mezőgazdasági Kiadó.

SZUJKÓ-LACZA, J. (1977): Az Ánizs, *Pimpinella anisum* L. (The anise, *P. anisum* L.) Magyarország Kultúrflórája N/**8.** pp. 95.

SZUJKÓ-LACZA, J.—SEN, S. (1977a): Numerical evaluation of phenotypic relationship among the Hungarian species of *Gentiana*. Acta Bot. Acad. Sci. Hung. **22**, 229—245.

SZUJKÓ-LACZA, J.—SEN, S. (1977b): Correlation coefficient study in some character pairs of the Hungarian *Gentiana* (*Gentianaceae*). Ann. Hist. Nat. Mus. Nat. Hung. **69**, 55—57.

SZUJKÓ-LACZA, J.—SEN, S. (1977c): Distribution, Diversity and equitability of the Hungarian species of *Gentiana* and *Gentianella ciliata* L. (*Gentianaceae*). Stud. Bot. Hung., **12**, 71—100.

SZUJKÓ-LACZA, J.—SEN, S. (1978): Architectural organisation and relationship of the Hungarian *Gentiana*. Acta Bot. Acad. Sci. Hung. **23**, 393—411.

SZUJKÓ-LACZA, J.—SZŐCS, Z. (1975): The architectural and the quantitative investigation of some characteristics of Anise, *Pimpinella anisum* L. **21**, 443—450.

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VARGAMYCES, A NEW GENUS OF HYPHOMYCETES ON SUBMERGED PLANT DEBRIS

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(Received February 1, 1979)

The paper contains the diagnosis of *Vargamyces* Tóth nov. gen. *Hyphomycetes* genus and its type species. The single species of the new genus occurs in biotopes of aquatic-semiaquatic character.

VARGAMYCES Tóth genus novum

Mycelium brunneolum vel paene hyalinum, ramificatum, septulatum, partim in substrato immersum, partim superficiale, hinc inde conidiophora simplicia vel rarius breviter 1—2-ramosa, brunneola, septata, sympodialia ferens. Sympoduloconidia plus-minus fusoidea, pro ratione magna, transversaliter septata, brunnea, in conidiophoris apicaliter et lateraliter singillatim disposita.

Species typica: **Vargamyces aquaticus** (Dudka) Tóth **comb. nova** (basionymon: *Camposporium aquaticum* Dudka, Ukr. Bot. Zhurn. 23. nr. 4. 91—92, 1966).

Char. emend. ut sequitur: *Mycelium brunneolum vel paene hyalinum, ramificatum, septigerum, conidiophora sympodialia, erecta, eramosa vel rarius breviter 1—2-ramosa, cca. 50—150 μm longa, apice et lateraliter conidia singularia ferentia. Conidia fusoidea, 90—150(—175)×14—19 μm, apice obtusa vel plus minus rotundata, brunnescentia — brunnea, cellula basali necnon apicali in statu juvenili pallida vel fere incolore, sed demum cellulis caeteris plus minus colore aequali, septis transversis 6—9(—12), ad septa constricta.*

Hab.: in partis putridis plantarum, imprimis ad folia arborum frondosarum in aqua submersis; saprophyton.

Hoc novum genus nominatum in memoriam JOSEPHI BENNONIS VARGA S. O. Cist., olim professoris historiae naturalis in gymnasio oppidi Eger (Comit. Heves, Hungaria), magistri auctoris dilectissimi.

Collectiones *Vargamycetis* aquatici in substratis naturalibus cultae. — Abbreviationes: exs. = materia exsiccata, praep. = praeparatum microscopicum in herbario auctoris adest. Fungus semper in foliis putrescentibus in aqua submersis, matrix: *Fagus silvatica* L., coll. auctor ipse, nisi alias indicatur.

In fonte infra montem Somhegy pr. pag. Bakonybél, montes Bakony-hegység, 26. 6. 1963. — In silvis Gyulaji-erdő pr. pag. Gyulaj (Comit. Tolna), 20. 3. 1965. *Quercus* sp. — In fonte Ágoston-forrás ad Síkfőkút pr. opp. Eger, montes Bükk-hegység, 7. 7. 1965. — In fonte infra montem Som-hegyese pr. pag. Mátrakeresztes, montes Mátra-hegység, 27. 3. 1966. leg.: Cs. DOBOLYI — In rivulo vallis Petnyáki-völgy pr. opp. Pécs, montes Mecsek-hegység, 1. 7. 1966. — In fonte inter Odorvár et Kisrét pr. pag. Bükkzsérc, montes Bükk-hegység, 5. 7. 1966. *Fagus silvatica* L., *Quercus* sp. — 10298. Ibidem, 25. 4. 1970. (praep.) — 10285. In ramo australi rivuli Gerence-patak ad Szömörke-völgy pr. pag. Bakonybél, montes Bakony-hegység, 29. 11. 1970. (exs.) — 10292. In fonte vallis Szömörke-völgy, 29. 11. 1970. (exs.) — 10283. In rivulo vallis Máré-völgy pr. pag. Magyaregregy, montes Mecsek-hegység, 7. 7. 1971. (exs.) — 10281. In rivulo Sombereksed pr. pag. Bakonykoppány, montes Bakony-hegység, 25. 2. 1972. (exs.) — 10286. In rivulo Vörös-János-séd pr. pag. Bakonybél, 25. 2. 1972. *Fagus silvatica* L., *Acer campestre* L. (exs.) — In rivulo vallis Hidas-völgy pr. opp. Komló, montes Mecsek-hegység, 1. 7. 1972. leg.: S. TÓTH et A. VASS — In fonte Tisztavíz-forrás pr. pag. Bakonybél, 4. 12. 1972. — 10278 et 10290. Ibidem. 14. 12. 1972. *Fagus silvatica* L., *Carpinus betulus* L. leg.: S. TÓTH et J. GÖNCZÖL (exs.) — 10289. In fonte Papkút pr. pag. Németbánya, montes Bakony-hegység, 14. 12. 1972. *Quercus* sp. leg.: S. TÓTH et J. GÖNCZÖL (exs.) — 10288. In rivulo vallis Jegenye-völgy pr. pag. Solymár, haud procul urbis Budapest, 17. 12. 1972. *Pinus nigra* ARN., in ligno putrido submerso. leg.: I. FEJÉR (exs.) — 10282. In fonte Tisztavíz-forrás, 1. 3. 1973. *Fagus silvatica* L., *Carpinus betulus* L. (exs.) — 10287. In rivulo Velemi-patak ad pag. Velem (Comit. Vas), 30. 10. 1973. *Salix caprea* L. (exs.) — 10296. In rivulo Nagyvasfazék-patak infra montem Nagy-Hideghegy pr. pag. Kóspallag, montes Börzsöny-hegység, 15. 1. 1974. leg.: J. GÖNCZÖL (exs.) — 10280. In fonte Tisztavíz-forrás, 1. 2. 1974. (exs.) — In rivulo Nagyvasfazék-patak, 14. 7. 1974. *Quercus* sp. leg.: J. GÖNCZÖL — In caverna
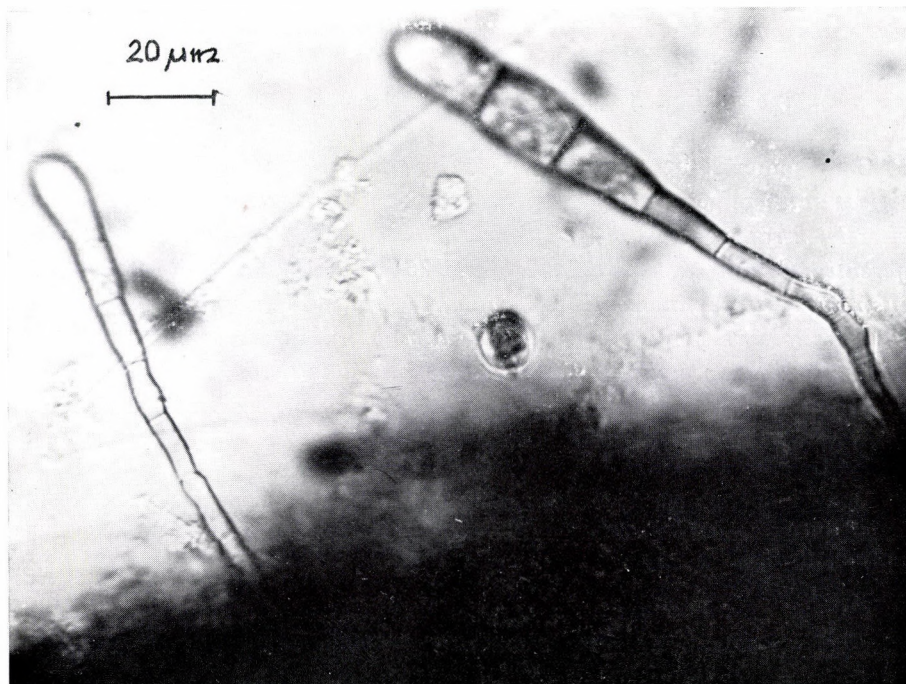
Fig. 1. Two conidiophores, both with a single young conidium

arboris vivae aqua repleta pr. pag. Szentliszló (Comit. Zala), 5. 8. 1974. leg.: J. GÖNCZÖL — 10276. In fonte Tisztavíz-forrás, 7. 11. 1974. (exs.) — 10291. In rivulo Csörgő-patak pr. pag. Mátrakeresztes, 22. 5. 1975. (exs.) — 10284. In fonte Tisztavíz-forrás, 16. 12. 1975. (exs.) — 10297. Ad Csurgó vallis Hidasvölgy, 15. 6. 1976. — 10275. In valle Hidasvölgy, 15. 6. 1976. In nido avis putrido. leg.: A. VASS et S. TÓTH (exs.) — 10277. In valle Petnyáki-völgy, 16. 6. 1976. In nido avis putrido. leg.: A. VASS (exs.) — 10279. In rivulo Malompatak pr. pag. Dömös (Comit. Komárom), 24. 3. 1977. Collectio diagnosi optime conveniens (exs., praep.).

The mycelium is brownish, or almost hyalin, ramifying, septate, partly superficial, partly immersed in the substratum. The conidiophores are sympodial, not ramifying, or sometimes with 1—2 short branches, brownish, septate. Conidia are brown, fusiform, with some transversal septa, situated one by one apically and laterally on the conidiophores. Type species: *Vargamyces aquaticus* (Dudka) Tóth *comb. nov.* (basionym.: *Camposporium aquaticum* Dudka), char. emend. in the following way:

The mycelium is brownish, or almost hyalin, ramifying, septate. The conidiophores are sympodial, erect, not ramifying, or, rarely, with 1—2 short branchlets, some 50—150 μm long; they bear single conidia apically and laterally. The conidia are fusiform, 90—150(—175)× 14—19 μm, their apex is obtuse, or more or less rotundate, brownish-brown, both the basal cell and the end one in the early state of their development are of a more pallid colour than the others, or almost hyalin, ultimately however all the cells of the conidium are almost completely of the same colour; they have 6—9(—12) transversal septa, at the septa are constricted.

Hab.: on putrid plant parts, mainly however on dejected leaves of deciduous trees submerged in water; saprophyte.

I named the *Vargamyces* genus in commemoration of J. B. VARGA S. O. Cist., my master, the teacher of natural history in the grammar school of the town Eger (Hungary) at that time.
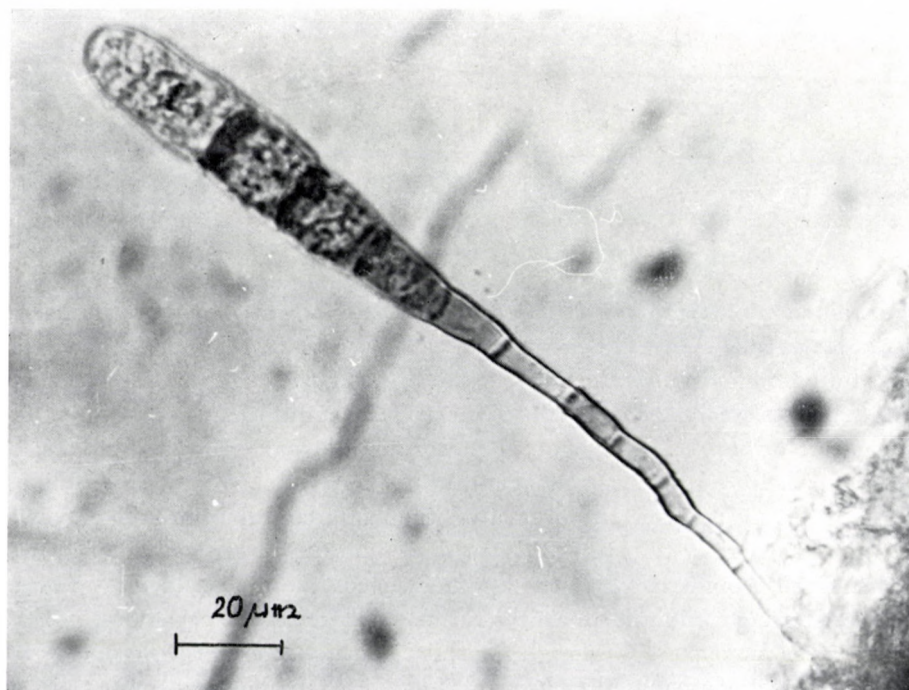
Fig. 2. Conidiophore with one young apical conidium (note the basal collarette)

I know the *Camposporium aquaticum* Dudka species only from descriptions. I could not manage to examine either the type or any other authentic material of it. In spite of this, I take it as certain that the fungus described by DUDKA and the one which I studied on rather many occasions are identical. I cultivated the fungus on the natural substratum collected together with the
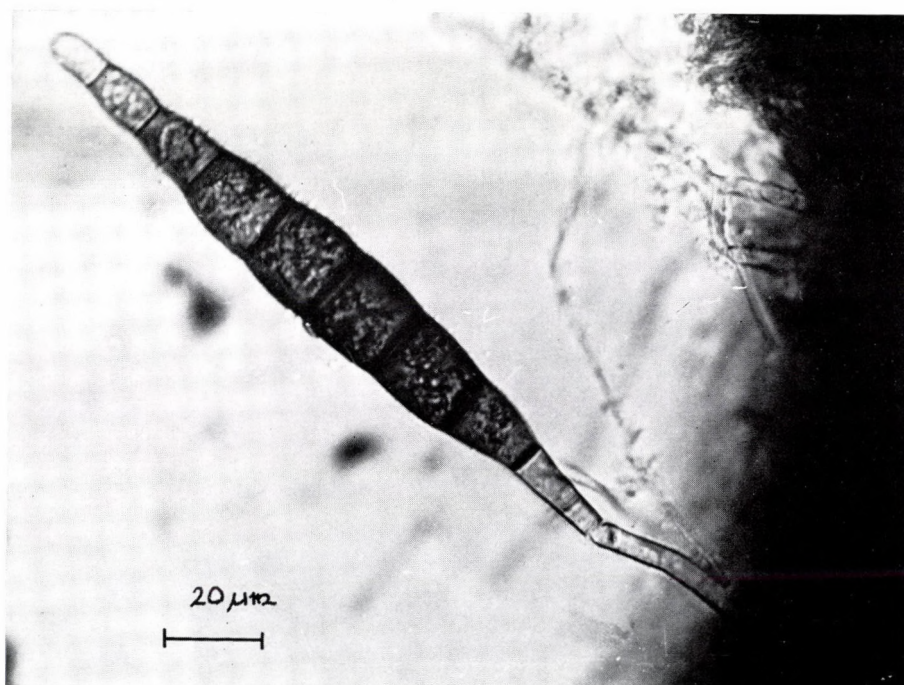
Fig. 3. Conidiophore on the start of fortgrowing with one obliquely staying mature conidium

fungus, since my attempt to cultivate it on artificial nutrient material has not so far come to fulfilment. The most important observations are described below.

The conidium always grows on the apex of the conidiophore, then the apex of the latter continues growing, whereby the conidium gets into an oblique position. Following this, newer and newer conidia can grow apically on the conidiophore. In our cultures, it occurred not only once that we were able to observe as many as even 12 conidia on the same conidiophore. The growing of conidium generally takes 1—3 days. The conidium in the course of growing is rather firmly connected with the apex of the conidiophore. The fully mature, obliquely staying conidium separates rather easily from the conidiophore: even a weak water movement is enough for this to ensue. Therefore, there is hardly any possibility that we could observe a conidiophore bearing more than one conidium in the case of freshly gathered material.

This explains that DUDKA, misled by the single conidium of the conidiophore, placed the fungus often observed also by him into the *Camposporium* genus.

The conditions are slightly different in the cultures than in the field, therefore, the conidia, staying on the conidiophores for a longer time, grow
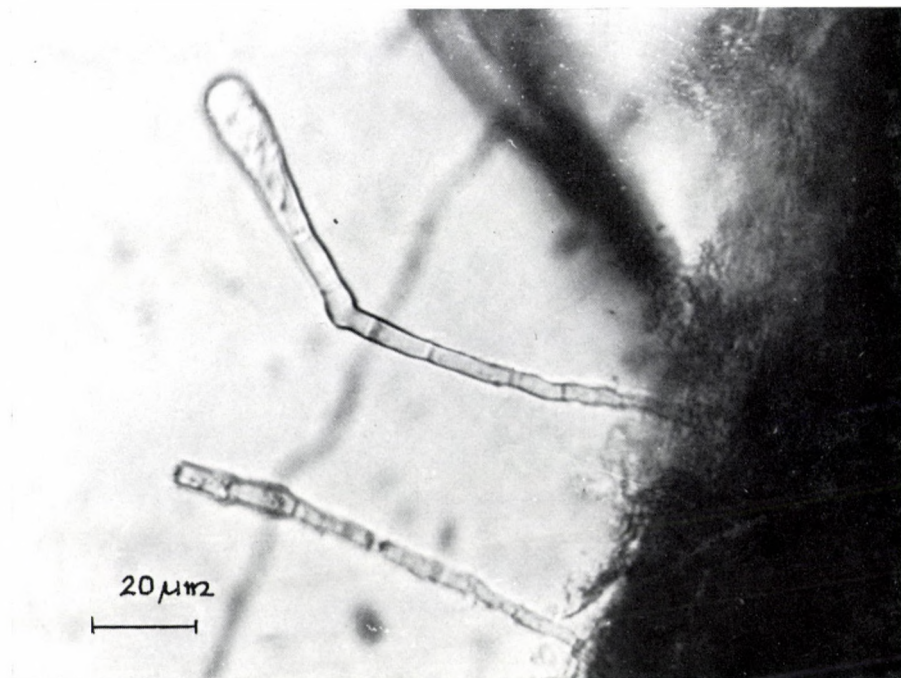
Fig. 4. Two conidiophores: one of them without conidium, the other fortgrowing with a young conidium

larger, and the number of their septa can also be more than that of the septa of fungi growing in the field. All those together provide an explanation that there are differences between the original diagnosis and our description.

Occasionally, but not often, we could observe also such conidiophores in our cultures that had 1—2 short side branches as well. On the branches, 1—2(—3) conidia could be observed. We had to mention this in our description.

The conidium may undergo unfavourable effects during both its growth and in its fully developed state. An interesting observation could be made by us in one of our cultures that dried up entirely in two weeks. After filling up the culture with water, after another period of 7—8 days conidia of a peculiar shape could be observed in the specimens. Some of the conidia, with abruptly rounding off at about the middle, continued growing up to apex, at some half width. We attributed the phenomenon to that during drying up the conidium

Fig. 5. Conidiophore with 3 conidia and 3 further conidia
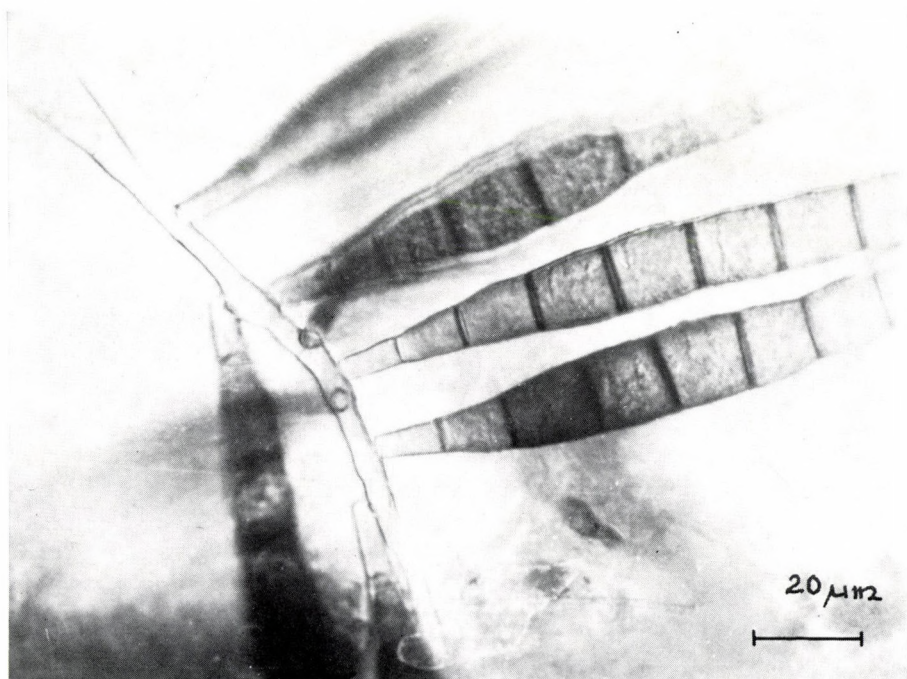
Fig. 6. Conidiophore with 9 conidia
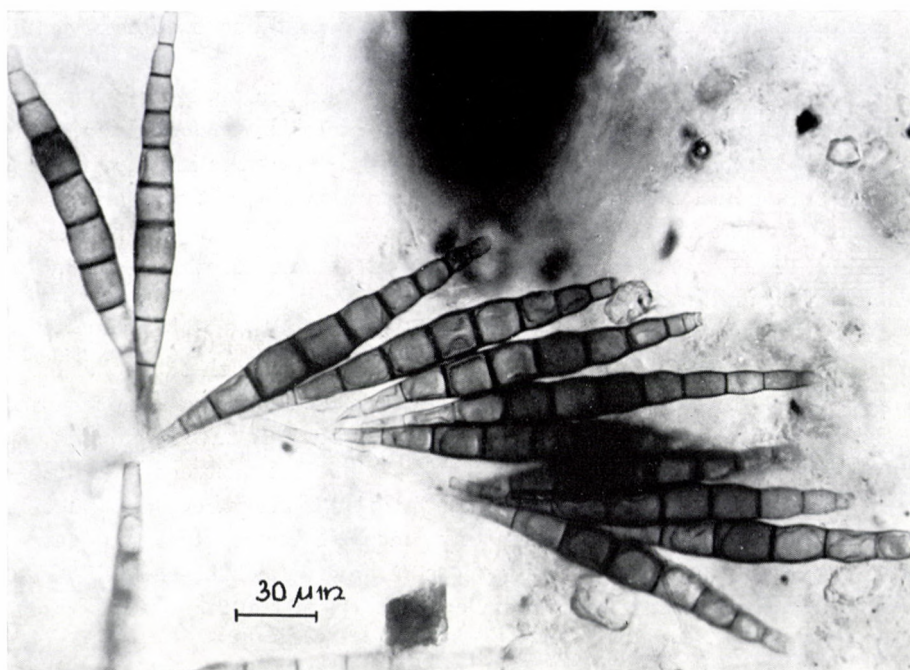
Fig. 7. Conidiophore with 12 conidia
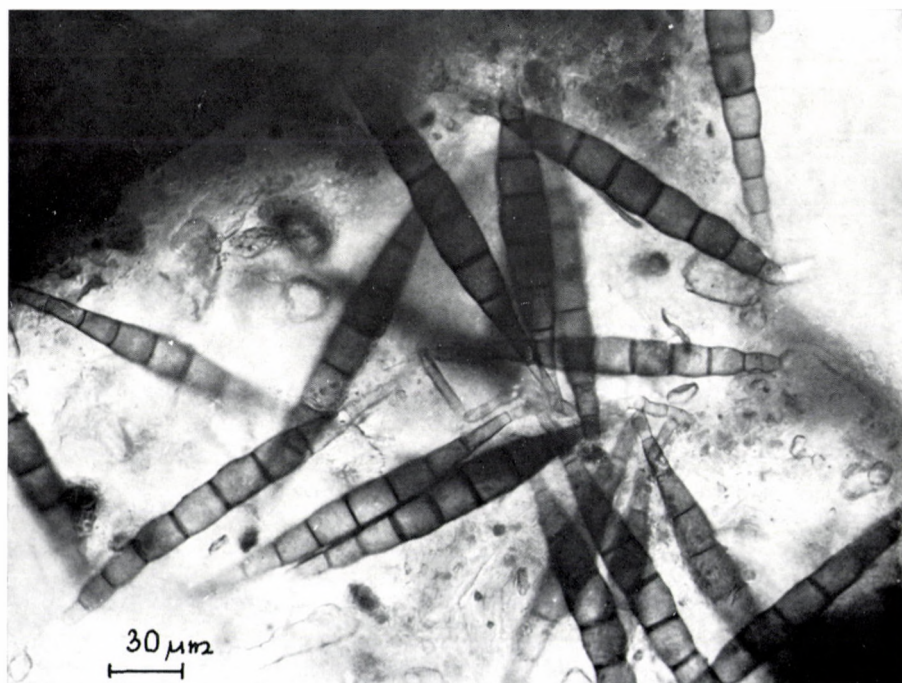
Fig. 8. Conidiophore and conidia

did not lose its ability to grow and when the circumstances resumed becoming favourable it continued growing.

The conidium of *Vargamyces aquaticus* is rather large, therefore it can be relatively easily injured. On the free end of a half-broken conidium, still on the conidiophore, a regular-shaped conidium grew out the middle of the last septum. This could be observed only on one occasion. It was also only on one occasion that we were able to observe that the conidiophore can also regenerate. This was testified by the collarette which was observable at the base of a conidiophore bearing conidia.

All these observations, then the brownish-brown colour of the mycelium and the conidiophore as well as the conidia, together with their character of being septate allowed us to draw the conclusion that the fungus is not primarily an aquatic organism. It did not appear to be impossible that besides its living in aquatic, submerse conditions the fungus can live in relatively dry conditions as well. We made attempts to prove this presumption by incubating decaying leaves which had been gathered in dry places. Years after the unsuccessful attempts, we succeeded in finding the conidia we had searched for, in two valleys, lying several km apart from each other, in the mountain Mecsek on the incubated leaf-pieces of bird-nests that had been lying and decaying each on the ground. Both nests originated from damp places, but the material did not let out water when pressed, and it was obtained from places higher and farther from the rivulet rather than the conidia could reach them from the rivulet (Nos 10275, 10277). Two years later, we again managed to find conidia (we did not enumerate them above), on beach leaves gathered in one of the damp valleys of the mountain Mátra. The leaves were collected also here in such places that made it very improbable that the conidia could in the observed quantity reach the leaves from the rivulet. The soil was rather damp also here. Finally, in 1974, J. GÖNCZÖL collected the beach leaves on which we could enjoy seeing the nicely developed conidiophores of the fungus after incubation, in the cavity of a beech tree. The caverna arboris was filled with water. In its vicinity, over a distance of several hundred metres, there occurred no river, nor stagnant water (see above, at the enumeration of the collections).

On the basis of what have been said above, we consider it as testified that *Vargamyces aquaticus* can find the conditions of its life not only in rivulets, in a submerse state, but also in somewhat drier conditions, and even in biotopes of damp character.

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ANATOMY AND LOCALIZATION OF THE ALKALOIDS OF THE FLOWERING PLANT CORYDALIS CAVA (L.) SCHWEIG. ET KÖRTE

By

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The authors examined and histologically have characterized the tuber, stalk, leaf and flower as well as the green and the ripe fruit of *Corydalis cava*. It has been stated that secretion vessels occur which are either uni-cellular or consist of groups of 3—4 cells. In the tuber, many parenchymatic elements, containing starch, can be found. The medullary rays are also large. The collateral bundles are characteristic of the stalk. As regards the leaf, the grouped hydatodes are to be emphasized. The papillary development of the endocarpium is characteristic.

The histochemical examinations point out the localisation of the alkaloids in the cell-wall, intercellulars and in the secretory vessels.

Introduction

C. cava (L.) Schweig. et Körte, is a very widespread plant in our rocky and beech woods, riverside forests, and mixed oakwood associations (Soó and KÁRPÁTI 1968). The plant aroused our attention if only because in the last decade Japanese researchers began to deal with this plant and with other related *Corydalis* soecies in detail (IUNZO IKASA 1966; NARUKO and KANEKO 1972; KAMETANI et al. 1971; NONAKA et al. 1973a, b). According to MANSKE (1969), there are more than 20 kinds of alkaloids with iso-kinolin frame, which belong in the types Protopin, Protoberberin and Aporfin. A total of 120 alkaloids have been described from the gene together with its isomers (survay by VERZÁR-PETRI and MINH HOANG 1978a). According to our own examinations, the main alkaloid of *C. cava* is the bulbocapnin of Aporfin type, and also the quantity of corydalin, which is of protoberberin type, is considerable (VERZÁR-PETRI and MINH HOANG 1978b). The total alkaloid content of the plant, depending on growth phase, varies it is the highest, amounting up to 2—5%, in the tuber (MINH HOANG and VERZÁR-PETRI 1978).

There is only a few information on the anatomy of the plant (METCALFE 1950), and the knowledge of the location of the alkaloids within the tissue is definitely inadequate.

On the *Fumariaceae* family we can read in KÁRPÁTI (1969) that its species do not contain latex. METCALFE (1950), however, calls attention to the milk tubes to be found in the family, and which can be uni-cellular or multi-cellular, with unknown contents. METCALFE adds to this observation his supposition that, as the *Fumariaceae* family is related to *Papaveraceae*, the secretion vessels to be found in them are similar to the laticiferous vessels.

THURESON-KLEIN (1970) and MOTHES (1966), among others, reported on the milk tubes or laticiferous vessels of *Papaveraceae*. It was especially the work of MOTHES from which it has become unambiguously clear that there are alkaloids in the laticiferous vessels. VERZÁR-PETRI (1973, 1975) found uni-cellular and multi-cellular jointed in *Vinca minor*, which belongs

in the *Apocynaceae* family, and she pointed out by means of histochemical and isotopical examinations that there were alkaloids present in the milk vessels.

Therefore, it seemed interesting to examine the anatomical relations, and within it the secretion vessels, of *Corydalis cava* belonging to *Fumariaceae*, and also to establish the location of alkaloids forming in the milk vessels.

Material and methods

The plant material which was to be examined had been gathered from a mixed beech-wood of Ságvári-liget, in April of 1976 and of 1977.

The organisms which were to be studied anatomically were fixed in alcohol of 40%. Then hand-made sections were prepared, and leaf-bleaching was carried out (SÁRKÁNY and SZALAI 1964).

The preparations were examined unstained, or stained with 0.5% toluene blue solution, placed in diluted glycerin, and framed, under a ZEISS/Jena Lumipan light microscope. The photographs were taken with Practica camera, on docu film and Orwo-Chrom diafilm (18 Din).

The histochemical alkaloid examinations were carried out according to the method of G. VERZÁR-PETRI (1973). For detecting the alkaloid in plant tissues, the following procedure was used: The hand-made sections were prepared from the samples always in fresh state, and part of them was put into two kinds of alkaloid reagents. Parallelly with this, control sections were always prepared, which were collected in water, then were examined — for comparison — covered in glycerine and framed in the usual way. The sections to be studied the histochemical were cut and put into alkaloid-reagent, and left for 4 hours. After taking the sections out, they were washed thoroughly again, covered in diluted glycerine and framed. For investigations we used a DRAGENDORFF-type reagent and a bromic one (4-Br-benzol-diazoniumfluorborate), which had earlier been used in our thin-layer-chromatographic examinations (VERZÁR-PETRI and MINH HOANG 1978). Differentiation (abs. alcoholic removal of alkaloid with 5% tartaric acid) recommended by JAMES (1950) was also carried out, in parallel sections. We considered only those reactions as acceptable which took place also after differentiation.

Results

1. Histological characterization

a) Tuber

On the basis of HEGI (1963), the tuber of *Corydalis solida* is of hypocotyl origin. According to KIRCHNER (1908), the tuber of *Corydalis cava* is also of hypocotyl origin. Since we did not carry out histogenetical examinations, we accepted this data. However, we wish to remark that the tissue structure of the full-grown tuber, and also that of the very young tuber, do not definitely confirm this statement. The diarch structure mentioned by e.g. by METCALFE (1950), and given as characteristic of *Fumariaceae*, is well-distinguishable in the young tuber.

The tissue structure of the fully-developed tuber which has become cavernulous is as follows:

On the residue of the rhizoderm, occasionally conical hairs can be found, which become suberized, while cracks and lenticels develop among them. The tuber is covered with the irregular phellom of two-rowed cells, which rather resembles the exoderm. Below the phellom we can find the 1-row-thick phellogen, which is of dipleuric function. The phelloderm con-

sists of parenchymatic, isodiametric and multiangular cells. The cortex is a parenchyma layer similar to the latter, and it extends up to the endodermis of CASPARian point (Fig. 1).

In the cortex, cell-groups can be observed, containing a kind of secretion of brown colour which are idioblasts (Fig. 2). In their longitudinal section they are elongated and consist occasionally of 2—3 cell-members. A parenchymatic pericambium of 2—3 cell-rows can be found under the endodermis. The vascular tissue comprises 2/3 of the tuber. Its characteristic is the dominant bast parenchyma and wood-parenchyma, containing ordinary starch grains, and being of a storing type. The starch grains are globular, concentrical and in general of 30—40 μm size. They fill the storing parenchyma cells up to overflowing. In addition, the bast parenchyma contains thin-walled tracheae and also secondary cells. No fibres can be found. The medullary rays are infundibuliform and contain starch. The cambium is wide, 8—10 cell-rowed and sharply differentiates from the other tissue zones. The contiguous, secondary xylem body is divided by the medullary rays, which mostly do not contain starch and are of 2—5 cell rows. Frequently, in the medullary rays rexigen passages occur, which make the woodbody loose, and rugged (Fig. 3). The number of traches is small, they constitute 5—8-membered and thin-walled groups, and after a certain time they become filled up clogged up with a kind of brown-coloured secretion. Occasionally, well-distinguishable, empty parenchymatic elements occur. Their function is unknown.

In the middle part, an enormous and ever-increasing rexigen passage develops, which tears the neighbouring tissues, and together with them also the primary sheaths as well.

In the old tuber the cortex can no longer be found. The periderm develops in the pericambium. Underneath, increasingly a widening dilatational zone can be observed, which consists of isodiametric, relatively thin-walled parenchymatic elements. In the dilatational zone, cell-groups containing secretion can be found. The vascular tissue system has only the secondary and contiguous part, which — considering its structure — is in agreement with those described above. The rexigen passage reaches the secondary woodbody.

b) Stem

The stem is of soft substance. By the time of flowering it is fully developed and secondary sheaths of smaller size also develop among the main sheaths. The stem is covered with epidermis of one-celled rows, the cells of which contain also some chloroplasts. In the epidermis, stomata can also be found, which will be dealt with in detail when discussing the leaf. Occasionally, cone-shaped, uni-cellular integumentum occurs. Under the epidermis, chlorenchymatous hypodermis develops which has 2-possibly 3-celled rows. No cortex boundary grows, but the collateral open vascular sheaths are embedded in the parenchymatic basic tissue without any transition. The primary vascular sheaths of large size are well-distinguishable; so are the small, secondary vascular sheaths, which are often double (twins). The latter come into existence differently from the usual way, not as a result of the functioning of the contiguous, interfascicular cambium, but as a consequence of the operation of locally developing meristematic groups.

The vascular sheaths are embraced occasionally and in places with meristematic-parenchymatic bundle sheaths. Unlike the *Papaveraceae* (METCALFE 1950), so sclerenchymatous bundle sheaths develop here. In the phloem part, along with the tracheae, secondary cells, and bast-parenchyma, brown-coloured secretion vessels can be found. No fibres occur. In the wood-part, in a considerable part of large spiral cell-wall-thickened trachea a brown-substance be detected. The wood-part is characterized by the small number of tracheids and wood fibres. The proto- and metaxylems are well-distinguishable (Fig. 4).

The intercellulars of the parenchyma in the ground tissue are filled with mucus secretion. It is also characteristic that sporadically in several parenchymatous cells a brown-
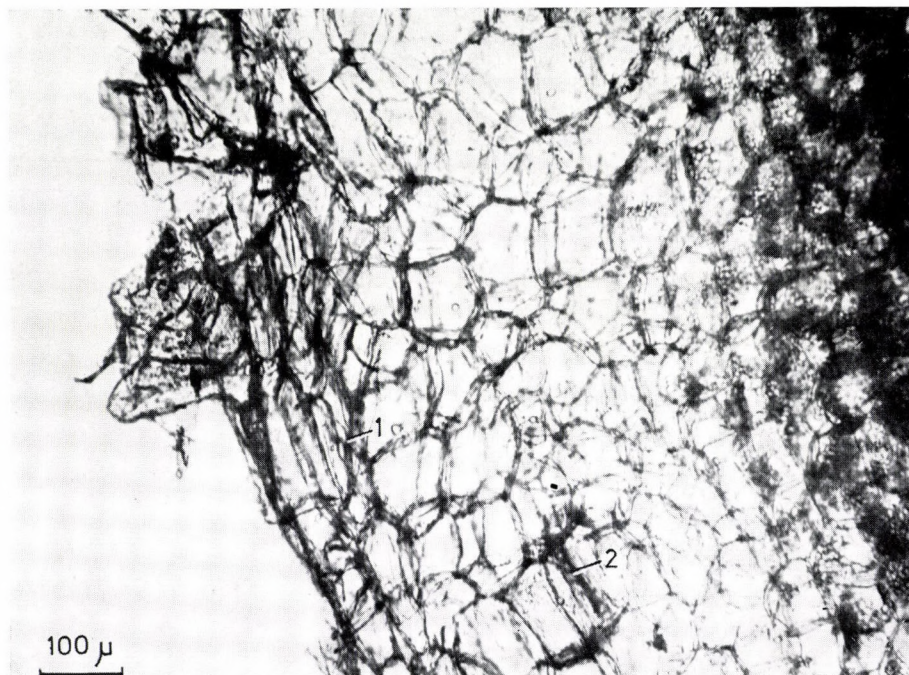
Fig. 1. Section of outer sheath from old tuber — 1 = phellom; 2 = secretion vessel
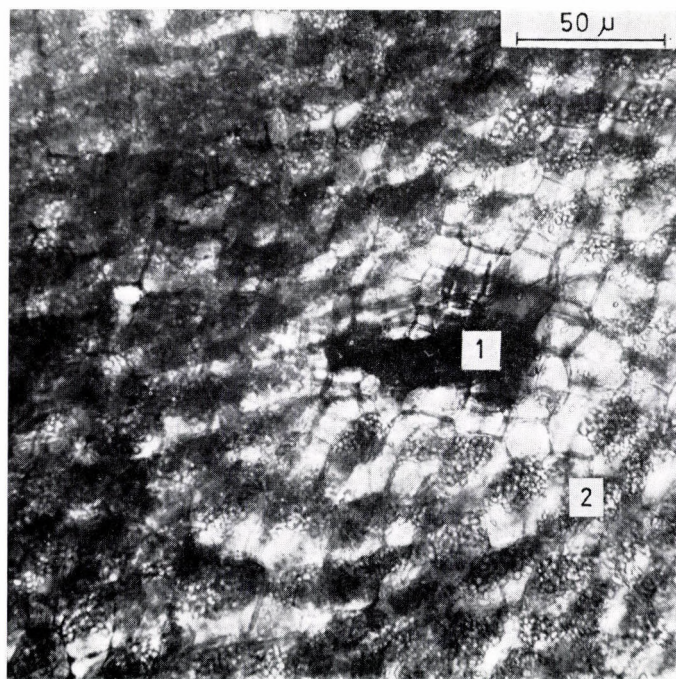
Fig. 2. Secretion vessels from the dilatational zone of the tuber (1), containing starch (2) parenchyma
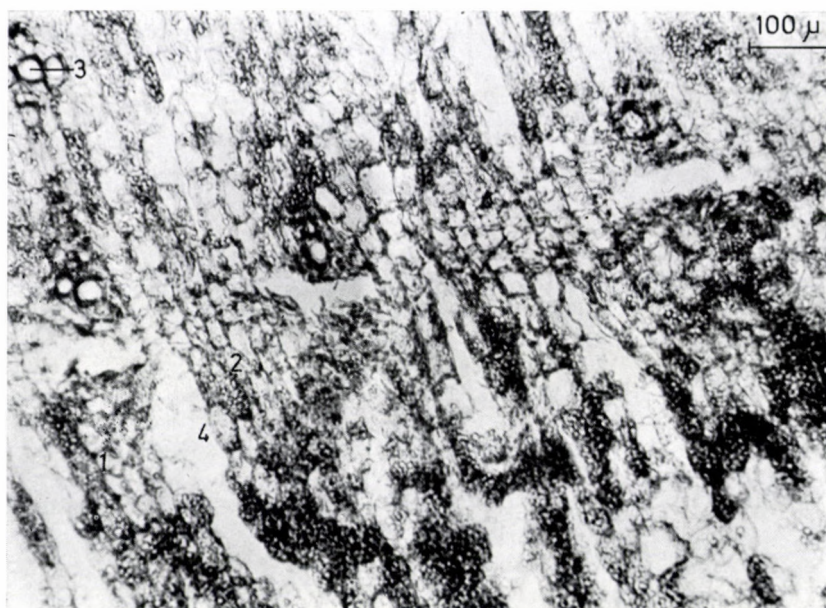
Fig. 3. Cross-section of the vascular tissue system of the old tuber — 1 = part of the outer sheath; 2 = cambium; 3 = trachea group; 4 = protruding medullary ray
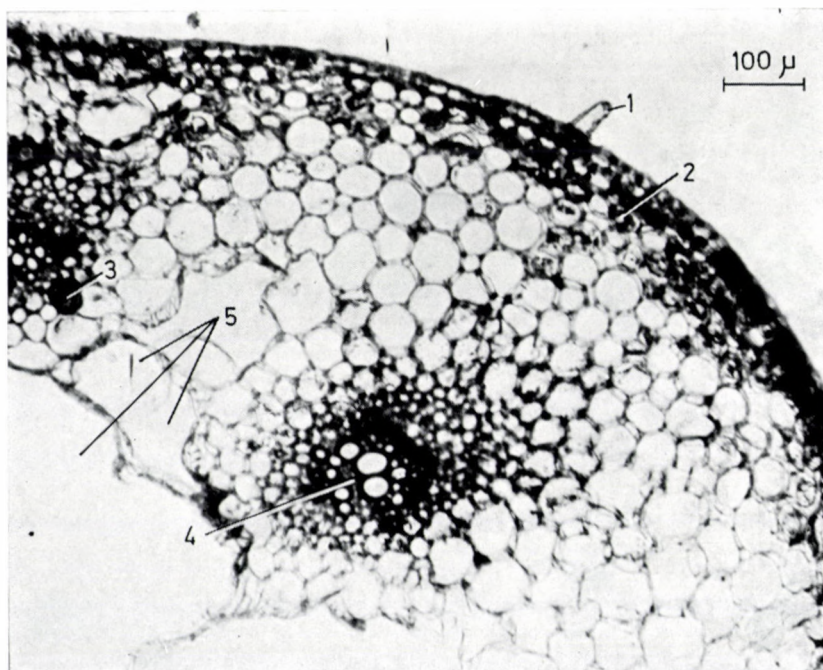
Fig. 4. Cross-section of the stalk — 1 = uni-cellular trichome; 2 = chlorenchymatous hypodermis; 3 = secretion vessel; 4 = collateral open vascular sheath; 5 = rexigen passages

coloured mucus can be found. The presence of starch grains is frequent, but in a quantity smaller than that found in the tuber.

The rexigen passage develops in the stem at an early stage; it is star-shaped and has 5—7 branches.

c) Leaf

It is of a unifacial homogeneous tissular structure. The cells of the epidermis on the abaxial surface, and of the adaxial one, are tangentially elongated, of a rectangular form, with slightly wavy edges. The stomata are to be found in both epidermises, but while on the adaxial surface there are hardly any, abaxial surface is densely filled with them; they consist of closing cells having a blunt triangular form or that of a slightly curved crescent, with narrow air passages among them. The cells closing the stomata are embraced by 1—3 secondary cells of different sizes; one among them is conspicuously small. The stomata are slightly sunk in the epidermis; they have rotund inner halos which often transform into rexigen passages, spreading in a tangential direction. In the epidermis hair formulas and glandular hairs occur sporadically. In the abaxial epidermis, grouped hydathodes can be observed, which consist mostly of 4 members (Fig. 5). Hydathodes can be found also in the *Papaveraceae* family (METCALFE 1950).

In the cross-section of the leaf, one midrib and, in two directions, 5—7 lateral ribs can be observed. The structure of the sheaths is in agreement with that described in respect of the stem. The sheath are embraced also here with a tiny parenchymatic layer of $\pm$ thicker wall. No definite sheath bundle occurs. On both surfaces of the midrib, but mainly on its abaxial surface, an angular collenchymatous hypodermis of a few rows develops (Fig. 6).

The mesophyll consists of isodiametric parenchyma the cells of which are of different sizes, with small intercellulars. Under both epidermises, a chlorenchymatous hypodermis of 1—3 cell-rows develops which is not a typical palisade-parenchyma, since its cells are not elongated. It is usually multi-layered under the adaxial epidermis. The leaf-edge is bluntly tapering, with one smaller vascular sheath near its apex. The secretory vessels, containing brown cells, can be observed here also sporadically in the ground tissue, and also in the vascular sheaths (see also the description of the stem). Further, it should be remarked that the cells of the adaxial epidermis are larger in cross-section than those of the abaxial epidermis, sporadically with dome-shaped air-retaining cells. The cuticle is thin in both epidermises.

d) Leaf stalk (Fig. 7)

The bulging lower part is covered with an epidermis having a stomata (see leaf blade); the chlorenchymatous hypodermis of 1—2 cell-rows can be observed also here, in the direction of both the adaxial and abaxial surfaces. A considerable part of the ground tissue consists of thin-walled, isodiametric parenchyma cells, with large rexigen passages, which mostly develop under and between the vascular bundles. The vascular bundles are collateral, and have a cambium. Their structure is in agreement with that found in the leaf-blade. The large primary and the small secondary bundles are characteristic. In the direction of the main sheaths, under the epidermis, groups of sclerenchyma cells develop. No trichoms can be found.
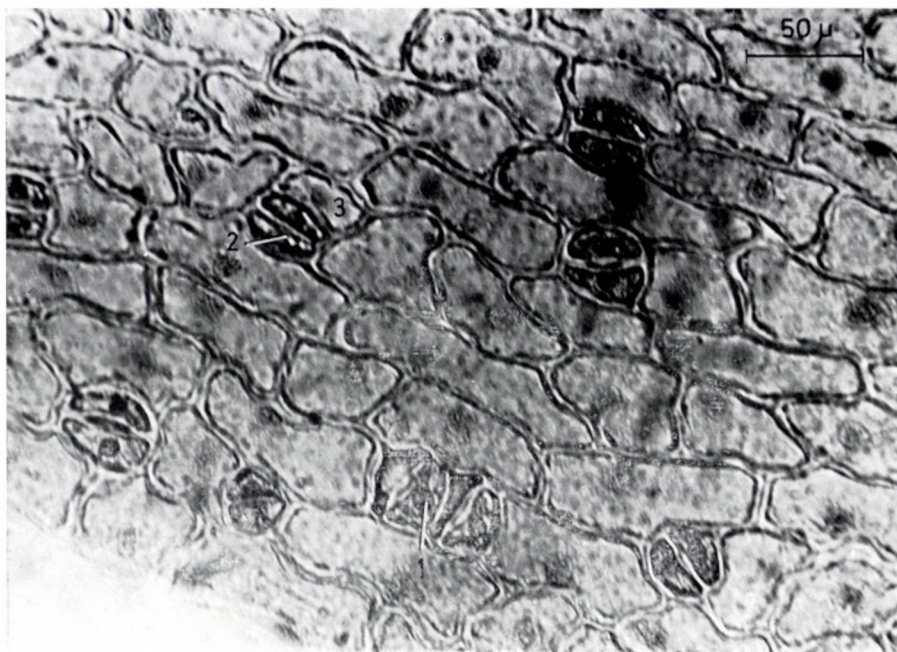
Fig. 5. Section of abaxial epidermis from the foliage leaf — 1 = grouped hydatode; 2 = closing cell of stoma; 3 = secondary cell
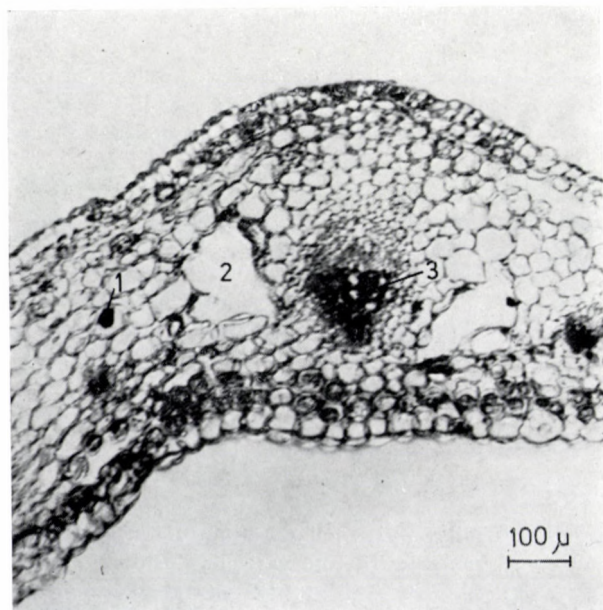
Fig. 6. Leaf cross-section — 1 = secretion vessel; 2 = rexigen passage; 3 = vascular sheath
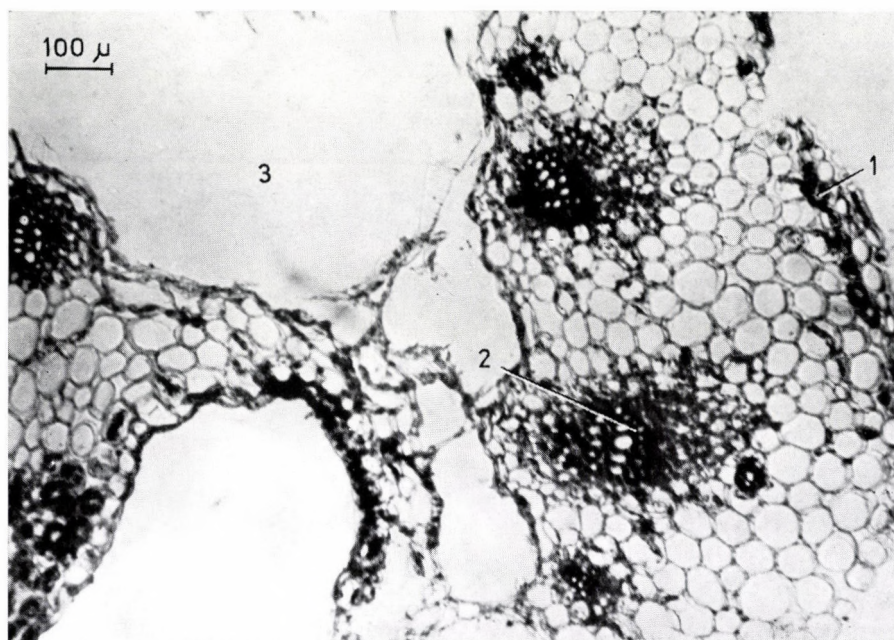
Fig. 7. Cross-section of petiole — 1 = secretion vessel; 2 = vascular sheath; 3 = rexigen passage

e) Flower

Corolla: In the bleached preparation the meandering-called epidermis of the corolla can be seen well, as well as the one-celled papilla which developed in the upper part of the corolla-tube. In the bottom of the corolla tube a thick-walled tissue layer of tightly adjusting cells develops (Fig. 8), the wall-thickening is pedunculate.

Pollen: it is oviform, with 3 openings for outlets, its oxine is of peduncular wall-thickening.

Pistil and ovules

The pistil consists of two main branches and several lobes; it is covered with thin-walled papillae (Fig. 9a).

In the bleached preparations, the anatropous ovule can be seen with two-fold integumentum and considerable nucellus (Fig. 9b).

Green fruit

The structure of the fruit wall is similar to that of the leaf; only the mesophyll is much narrower, and — alternately with the vascular sheaths rexigenic air passages are located in it.

Fully-developed fruit: its outer layer consists of straight-walled, rectangular epidermal cells, with some stomata among them. Under this is a chlorenchymatous hypodermis layer of
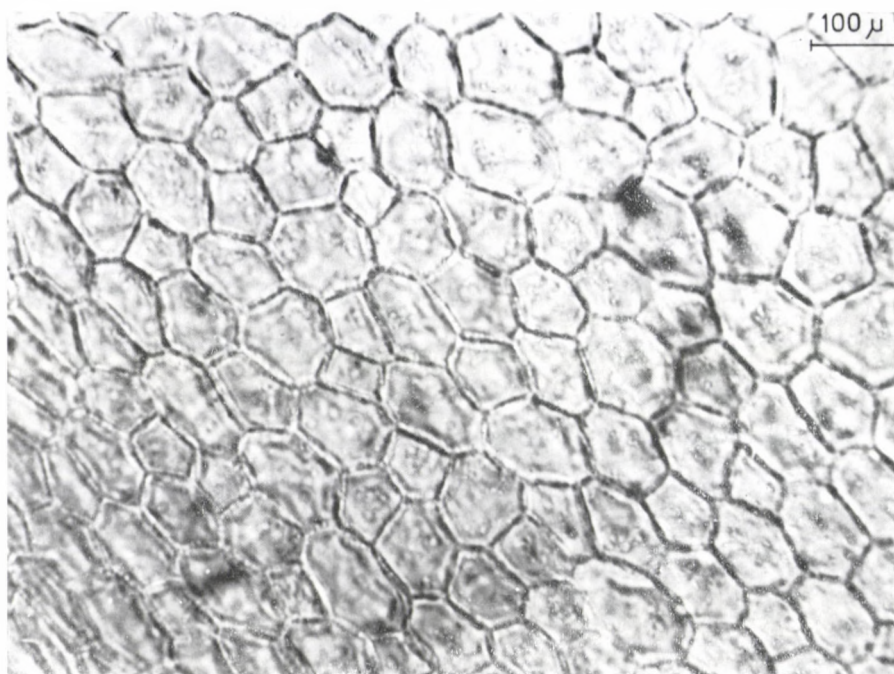
Fig. 8. Section of bleached petal

1—2 cell-rows which becomes a 3—4 cell-rowed mesocarpium, into which the tiny, collateral, initially opened vascular bundles are embedded, having an anatomical structure similar to that found in the stalk. In the zone of the sheaths, smaller or greater rexigenic passages develop in the ground tissue. The endocarpium is conical, consists of papillary cells, the wall of which is pitted. This tissue area is very characteristic of the fruit wall (Fig. 10).

The placenta develops in the direction of the midrib. It consists of a relatively small tissue trim, with parenchymatic structure. The sheaths of the funicle adjusting the ovules anastomose into this at the level of the various ovules the vascular sheaths show a remarkable development and contain tracheae in abundance. The fusion of the main bundle and 2 secondary bundles is also frequent (Fig. 11).

f) The histological structure of the seed

The outer cell row of the testa consists of brown-coloured, smooth-surfaced cells having outwardly thickening-walls. It is elongated in the longitudinal axis, and contains phlobaphene substances. In the cell wall pits develop in all directions. After this epidermal layer follows the nutritional supply layer of the testa, which consists of a thicker-walled parenchyma of 8—10 cell rows. The testa are closed by a tangentially squashed pressed pigment layer. The caruncle consists of a thin-walled parenchyma tissue. It is of perispermium and endospermium parenchymatic character. The former develops only 1—2 cell-rowed tiny cells, while the cells of the endospermium are rectangular, contain starch in abundance aleurone grains and fatty oil. The embryo is curved and located centrally; it is built up of meristematic elements.
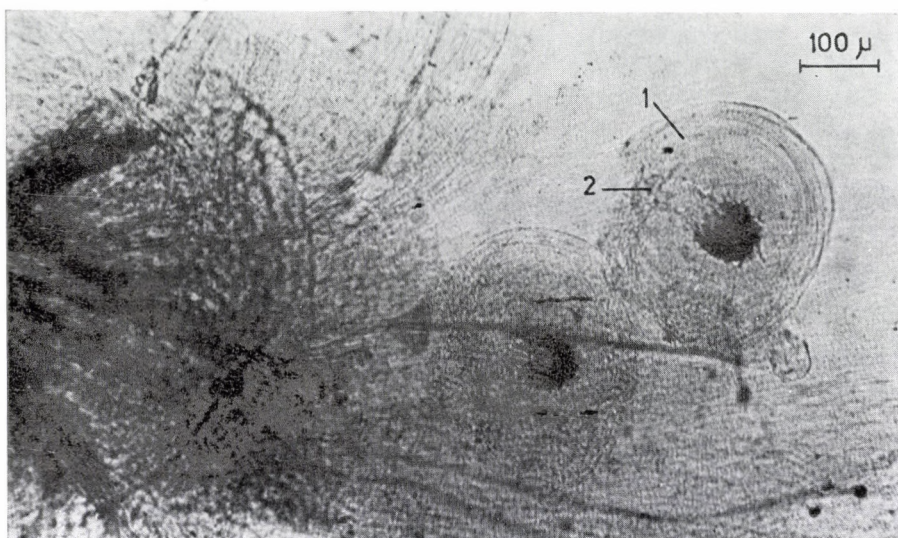
Fig. 9a. Section of bleached pistil — 1 = integumentum; 2 = ovule
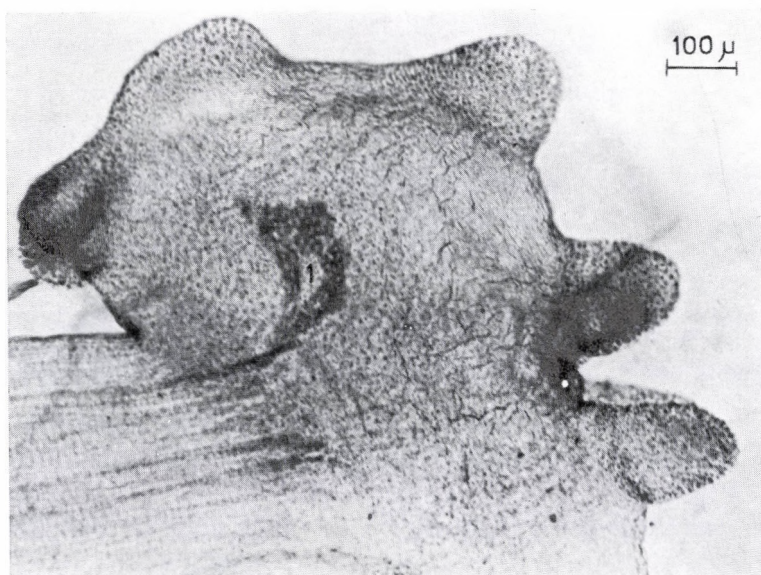
Fig. 9b. Bleached pistil — 1 = vascular sheath

2. The localization of the alkaloids

The alkaloids accumulate in the cell-walls, intercellulars and in the brown-coloured vessel (Figs 13, 14, 15 and 16). The alkaloid localization taking place in the cell wall is relatively rare, but a known phenomenon; for example

the berberine is located in the cell-wall of the barberry, *Berberis vulgaris* (TUNMANN and ROSENTHALER 1933).

We consider it noteworthy that similar observations could be made also in the case of *Corydalis cava* partly containing alkaloids of protoberberin type. It is possible that the various alkaloid types are localized in varying areas in the cells or tissues. Here we refer to the doctoral thesis of G. VERZÁR-PETRI
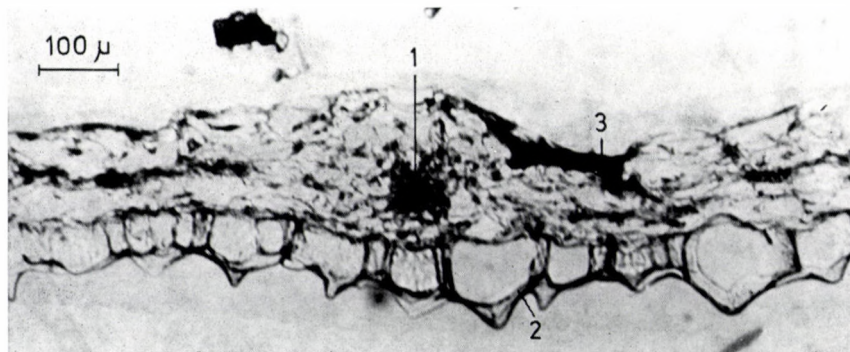
Fig. 10. Matured carpium wall — 1 = vascular sheath; 2 = papillary endocarpium; 3 = secretion vessel

(1973), which has been written on this topic. The author has found several kinds of alkaloid localization; for example, the alkaloids with indole skelet of *Vinca minor* could be detected mainly in milk tubes, and the alkaloids of tobacco were localized in idioblasts containing secretion of a broun colour. The tropane-framed alkaloids crystallized in the vacuoles of certain parenchymatic cells. Similarly, vacuole localization could be found also in *Valeriana officinalis*. In the plant species enumerated above, the alkaloids could always be detected, in addition to the main localization areas, in the intercellulare too, which is an indication of these compounds being transported within the tissues.

In the present case, in *Corysalis cava*, the cell-walls can be considered as end apparatuses of localization. The intercellular alkaloid reaction is mainly an indication of the alkaloids being transported. A further characteristic is the development of secretion vessels in the parenchyma of the ground tissue, which also accumulate the alkaloids. It could be stated that the cell-wall of the tracheae of the vascular tissues, as well as the secondary cells occuring in the bast part, and the bast parenchyma have a part in the accumulation of the alkaloids (Figs 17 and 18). With respect to this very active tissue area, this way even be the site of alkaloid formation, since there is living plasma in its elements, and several organic materials are transported. The parenchyma of
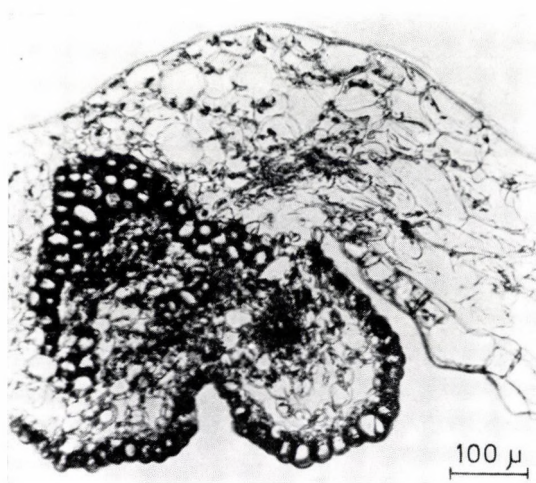
Fig. 11. Section of placenta with vascular sheaths
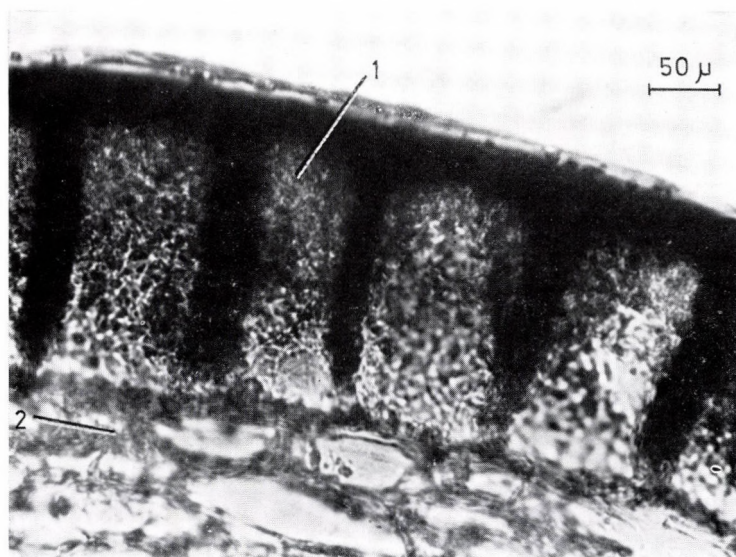
Fig. 12. Cross-section of the seed — 1 = testa epidermis; 2 = supply layer

the ground tissue also has a considerable role in the accumulation of alkaloids, by means of its cell-wall, intercellulars, and its special secretion vessels. This observation is in correlation with our own results obtained in the course of the quantitative examinations of alkaloids, since the largest quantity of tissue mass (parenchyma and vascular tissue) develops in the tuber (MINH HOANG and VERZÁR-PETRI 1979).

REFERENCES

HEGI, G. (1963): Illustrierte Flora von Mittel-Europa. Carl Hanser Verlag, München.

JAMES, W. O. (1950): In MANSKE, R. H. F.—HOLMES, H. L.: The alkaloids I. Acad. Press New York, London.

JUNZO IKASA et al. (1966): Constituents of corydalis species application of TLC and gas chromatography to *Corydalis* alkaloids. Yakugaku-Zasshi, **86** (5), 396—399.

KAMETANI, I.—IHARA, M.—HONDA, T. (1971): Morphinandienone alkaloids of corydalis incisa. Phytochemistry, **10,** 1881—1883.

KÁRPÁTI, Z. (1969): A növények világa. (The world of plants) I. Vol. II. Gondolat, Budapest.

KIRCHNER, O.—LOEVE, E.—SCHRÖTER, C. (1908): Lebensgeschichte der Blütenpflanzen Mittel-Europas. Band. 1. Abteilung 1., Stuttgart.

MANSKE, R. H. F. (1969): Alkaloids of fumariaceous plants. LVII. Miscellaneous observations. Can. J. Chem. **47** (7), 1103—1105.

METCALF, C. R. (1950): Anatomy of the Dicotyledones. Oxford, Clarendon Press.

MINH HOANG, P. T.—VERZÁR-PETRI, G. (1978): The alkaloidal pattern during ontogeny in *Corydalis bulbosa* (L.) Pers. Planta Medica in press.

MOTHES, K. (1966): Bemerkung zur Biologie d. Alkaloide. Abb. d. Akademie der Wissenschaften Berlin, **3,** Akad. Verlag. Berlin, 27—34.

NARUKO, Sh.—KANEKO, H. (1972): *Corydalis stewartii.* Phytochemistry, **11,** 2642.

NOSAKA, G.—OKABE, H.—NISHIOKA, I.—TAKAO, N. (1973): Alkaloids of *Corydalis incisa* Pers. I. On the Nonphenolic Tertiary bases. J. Pharm. Soc. Japan. **93** (1), 87—93.

NOSAKA, G.—KODERA, Y.—NISHIOKA, I. (1973): Alkaloids of *Corydalis incisa* Pers. II. The structure of Corydalic Acid Methyl Ester. Chem. Pharm. Bull. **21** (5), 1020—1026.

NONAKA, G.—NISHIOKA, I. (1975): Alkaloids of *Corydalis incisa* Pers. V. The structures of Corydalis pirone and corydalisol. Chem. Pharm. Bull. **23** (2), 294—298.

SÁRKÁNY, S.—SZALAI, I. (1964): Növényszervezettani gyakorlatok. (Plant anatomical physiological exercises) 2. 2nd edition, Tankönyvkiadó, Budapest.

SOÓ, R.—KÁRPÁTI, Z. (1968): Növényhatározó. II. (Plant taxonomical textbook) Tankönyvkiadó, Budapest.

TUNMANN, O.—ROSENTHALLER, L. (1931): Pflanzen mikrochemie. Bornträger, Berlin.

THURESON-KLEIN, A. (1970): The development and fine structure of the articulated laticifers of *P. somniferum.* Annal of Botany **34**/136, 751—759.

VÁGUJFALVI, D. (1966): Die Aufnahme der Alkaloide in die Milchgefässe und ihr transport in latex. Zeitschrift für Pflanzenphysiologie. **55**/4, 322—326.

VERZÁR-PETRI, G. (1973a): Alkaloidok képződése és lokalizációja növényi szövetben. (Formation and localization of alkaloids in plant tissues). Thesis for degree of D. Sc. Budapest.

VERZÁR-PETRI, G. (1973b): Histochemical and histoautoradiographic examination of alkaloid localization in the vegetative organs of *Datura innoxia* Mill. Acta Botanica Sci. Hung. **18**/1—2, 257—271.

VERZÁR-PETRI, G.—MINH HOANG, P. T. (1978): Chromatographische Trennung der Alkaloiden von *Corydalis cava* L. (Fumariaceae). Sci. Pharm. **46,** 11—15.

VERZÁR-PETRI, G.—MINH HOANG, P. T. (1978): Keltike félék ismertetése. (The review of Corydalis sp.) Gyógyszerészet.

MINH HOANG, P. T.—VERZÁR-PETRI, G. (1979): The formation of alcaloid content in Corydalis cava (L.) Schweig. et Körte. during ontogeny, Planta Med. in press.
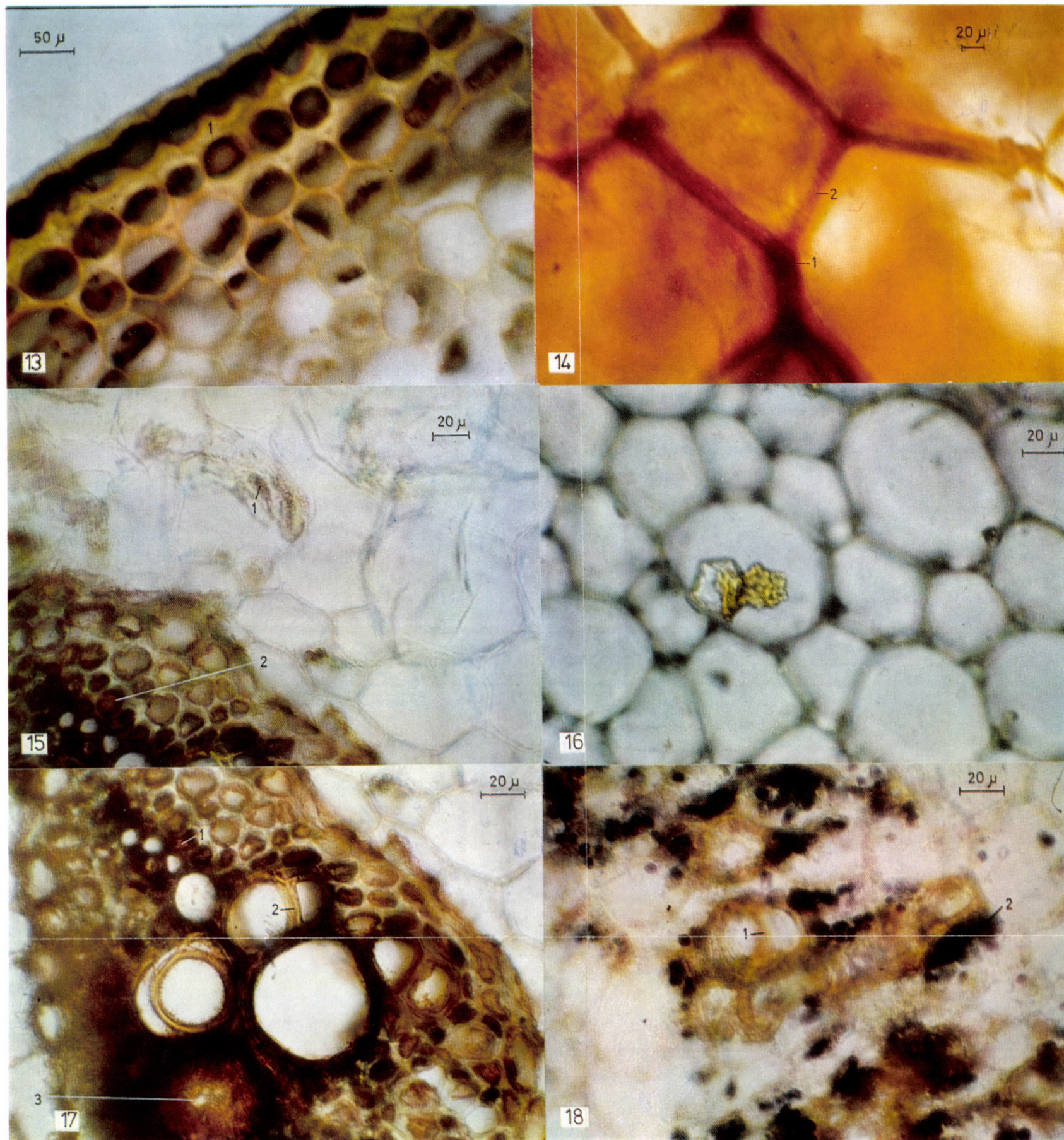
Fig. 13. Stalk cross-section with alkaloid reaction — 1 = positive reaction in the cell-wall after using DRAGENDORFF's alkaloid reagent

Fig. 14. Alkaloid-positive reactions with bromic reagent in the cortex of the tuber — 1 = intercellular? 2 = cell-wall

Fig. 15. Alkaloid localization in the stalk, pointed out by using Dragendorff's reagent — 1 = secretion vessel cell group in the outer sheath; 2 = secretion vessel in the phloem part of the vascular sheath

Fig. 16. Alkaloid reaction in the parenchyma of the petiole (bromic reaction)

Fig. 17. Localization of alkaloids in the vascular tissue of the stalk (DRAGENDORFF reaction) — 1 = secretion vessel in the bast phloem; 2 = alkaloid-positive cell-wall in the trachea; 3 = secretion vessel in the woodpart

Fig. 18. Alkaloid reaction produced by using DRAGENDORFF reagent in the vascular tissue of the tubes — 1 = the cell-wall of the trachea is alkaloid-positive; 2 = reaction of starch with the iodine content of the DRAGENDORFF reagent

RECENSIONES

K. Rasbach, H. Rasbach, O. Wilmans: Die Farnpflanzen Zentraleuropas. G. Fischer, Stuttgart, 1976. 304 pp, 154 illustrations, 79.— DM.

This book of large formate and luxurious lay-out, which is published in its second edition, is partly a photo-album and partly a scientific work which at the same time popularizes knowledge. The 95 Central-European Pteridophyta species are described in excellent habitat pictures, in natural environment, in 106 quarto plates. The general part deals not only with the development and system of the Pteridophyta individuals but also with the history of their development — with the species evolution, geobotanical relevances, well illustrated in a very up-to-date way in the case of several fossil species. In the description the species are presented by large biotopes (without the infraspecific taxa; only a few deviating cytotypes are mentioned), without descriptions, but with interesting morphological, ecological and sociological remarks. A few hybrids and newly-described still doubted taxa (for example, *Asplenium eberlei*) are also given a place in the volume. This beautiful book is appreciated rather as a photo-album.

R. Soó

J. Landwehr: Wilde Orchideen van Europa. I—II. 's-Graveland, 1977. 575 pp., 258 quarto Colour plates. 127. 50 Hfl.

Recently ever more beautiful works have been published on European orchids, partly with colour photos, partly with reproductions of original aquarelles, but Landwehr's book exceeds all of them in respect of layout, fineness, and decorative effect. It presents the perfect habitat pictures, inflorescence and certain flowers of the species of Europe, the Mediterranean, and Asia Minor and, within them, those of a great number of infraspecific units. Only a few rare taxa, have been left out mainly Eastern ones, which were not available for the author either in the original habitat or in coloured slides. However very many forms are presented for example in *Dactylorhiza maculata*, 22. Most of the pictures are true to life, although the colours are sometimes too vivid. Unfortunately, the colour picture of *Dactylorhiza fuchsii* subsp. *sooiana* (42 t. 3. f.) from Czechoslovakia is false; this taxon is a Hungarian endemic subspecies in an entirely different colour. The authors follows in a considerable part the works on orchids of this book reviewer, thus, more than 65 taxa validly bear the referee's authority even that of Olga Borsos. In the case of many forms which have not been seen in life, the drawings were made of specimens from the herbarium, for example, those of the Botany Department of Budapest. The transcription of *hunyadensis* into *huneadensis* is not correct. The author stained several specimens from Transylvania; incidentelly be visited almost all the European socialist countries, and also North Africa and Asia Minor. In comparison with other — partly descriptive, partly scientific — new illustrated works on orchids, it can be stated that Nelson's monographs (*Ophrys, Serapias Dactylorhiza* and smaller genera 1962, 1968, 1976), with their tremendous amount of drawings on the details, provide more ample information but the evaluation given in them is often very specific, and even mistaken, as has been pointed out elsewhere; the books of the couple Danesch (Orchideen Europas I—III, 1962, 1969, 1972), with their marvellous large colour photographs are unparalleled, but with the binary description of the tremendous amount of hybrid forms the authors are exaggerating, mainly in the *Ophrys*. The text—which,

unfortunately, is in Dutch presents the descriptions, conditions of occurrence, and distribution of the species and forms, sometimes with critical remarks and small but appropriate area maps. Of the 16 newly described forms there are only a few which are important. The work of wonderful layout and very great value ends with the taxonomic keys of the *Dactylorhiza*, *Orchis*, *Ophrys* and *Epipactis* species.

R. Soó

FROEHNE, D. and JENSEN, G. Systematik des Pflanzenreichs unter besonderer Berücksichtigung chemischer Merkmale und pflanzlicher Drogen. G. FISCHER, Stuttgart. Ed. 2. 1977. 308 pp, 123 figures, 30 structural plans, 242 chemical formulae, 38. — DM.

This very adept textbook written with an emphasis on the chemotaxonomical characteristics (cf. the increase in the number of structural formulae) is a newer, revised edition of Systematik des Pflanzenreichs (reviewed in Acta Bot. Hung. *20*$_{4}$ 298—399, 1974), without altering the structure of the original system. Compared with the first edition there are short introductory chapters on systematization, nomenclature, chemotaxonomy and the basic notions of morphology, as well as the chemical dictionary and the survey of poisonous plants. My critical remarks written a few years ago are still valid even today; I invariably hold it inappropriate to start the *Amentiflorae* subclass with *Hamamelidales;* I suggested earlier (1973—1975, cf. Taxon 1975) that it should be named *Eucommiidae*, but since the situation of the latter ordo has recently become debated (cf. WAGENITZ 1976), now I think *Fagidae* would probably be suitable. *Hamamelidales* are both morphologically (hermaphroditic flowers, apocarp ovary) and chemically (polyphenols, as leucoanthocyanins, leucodelphinidin, flavonols, as miricetin, ellagic acid, hamamelose) closely related to the *Rosidae* subclass (with me, too). In spite of certain questionable points in the author's conception, the book is elaborated in a clever way and excellently illustrated, it can be warmly recommended as a textbook of researchers and students of today.

R. Soó

H. MEUSEL—E. JÄGER—S. RAUSCHERT—E. WEINERT: Vergleichende Chorologie der zentraleuropäischen Flora. G. FISCHER, Jena. — I. 1965, Text 583 pp, 1—251 charts — II. 1978, Text 418 pp, 258—411 charts.

At the time of the publication of Vol. I of the MEUSEL and co-workers' huge area atlas, Acta Bot. Hung. did not publish reviews, thus I wrote about it only in Bot. Közlem. *54*, 606—607 (1967). After 13 years and that Vol. II has also been published I have the opportunity to mention it. MEUSEL's chief aim in life was the cultivation of floristic plant geography, chorology. His first attempt (Vergleichende Chorologie, 1943) — apart from the poor quality of the layout of the book — had a sad fate, the copies—with a few exceptions fell victim to the war. As a professor of Halle, his main objective — as also his co-workers' — was accurate areal geographical mapping of the species of the Central-European flora. As a result of long years spent in work, Part 1 of Chorologie (*Pteridophyta*—*Fabaceae*, with more than 1000 maps) came into existence — it was published in 1965. Part 2 (*Fabaceae*—*Plantaginaceae*, with 652 maps) was published in 1978, and we shall have to wait certainly for a long time for Part 3 (in ENGLER's system). Both parts are divided into text and map. In the Introduction of Part I, the taxonomical-floristical and cartographical bases for depicting the area are discussed, then the floristical-plantgeographical categoriation of the extratropical Eurasia is given. It is regrettable here that — although MEUSEL cites and uses the relaxant works of references — he nevertheless places the Pannonian floral province (Pannonische Provinz) again into the region of Pontus, and it follows from this that the Hungarian Central Range of Mountains are placed here with the submountain region of the Eastern Carpathians (Matrische Unterprovinz), and the Plain (Alföldische Unterprovinz). Taken out of its neighbourhood, West-Pannonia, belongs to Pränorisch-Slovenische Unterprovinz of the Central-European floral province, while the adjacent Alps to the Alpische Unterregion. The Eastern and the Southern Carpathians now appear within the Karpatische Unterregion of the Central-European region, then under the Sub-Mediterranean Unterregion of the Macaronesian-Mediterranean region. The earlier notion of Transdanubicum is confused with that of the Transdanubian Central Range of Mountains, etc. Our recent plantgeographical works are not considered in the book. Taken all in all, the rather conservative categorization which is difficult to comprehend cannot be considered as successful. Chapter 3 (and, similarly, Chapter 1 in part II) give a comparative survey of

area forms of the individual families — almost as a chrological characterisation of them, with several excellent maps. Chapter 4 — and Chapter 2 in Part II — are the lists, that is, the enumeration of the almost total number of Central-European species and related species or taxa. In these lists we can find on the one hand the determination of the area ("Arealdiagnose"; the word in boldface in it provides the notion we understand under floral element or geoelement), while in the column "floral element" — by a very clumsy terminology — almost the whole distribution of the taxon at issue is crowded. This is how, for example, *Ceterach officinarum* will become "Med-submedturcest-armoric-brit-südsubatl"; *Anemone sylvestris* "Ze-sarm-subboreoross-süd-mittel-sibir-jacut-daur"; *Geranium palustre* "(zentral)-ostsubmed-mo-subatl-sarm-westsubboreoross" element (but there are even much longer designations, with 8—10 names). It is a pity that it is so much in contradiction with the WALTER-type geoelement designation, and with the concise but expressive terminology used by us. Nevertheless, this list presents a survey with no precedent on the Central-European species and their relatives, although it often tries to satisfy us both here and in the maps with a wide frame of species and morphological spheres (with designations like agg., sp. coll., s. l.). By this, naturally, the indication of many interesting and significant small species' areas is missing, sometimes even that of "good" species; for example, there is only one *Mentha* occuring in the list. All the more valuable on the other hand that the areas of far-related species are presented (regrettably, because of the small size of the maps, they are sometimes blurred). This method is probably even right, since we are given a better survey of the complete areas of the individual morphological spheres, but on the other hand we should often like to go into details, for example, to see a more accurate picture of the distribution of certain vicarious small species. — The last chapter is a key to the maps, mainly from taxonomical and chorological viewpoints, with a list of the sources of all the area maps published. It can be seen from this, what a tremendous amount of work was undertaken, and what a wide scope of literature had to be consulted so that the various maps could be even if only approximately accurate. The authors review within the agg.-s the view of various taxonomists, sometimes without taking a stand themselves definite; Hungarian papers are in general taken into consideration. We should not resent the fact that certain reports are incomplete. The task was especially difficult in relation to areas outside Europe, for with respect to the European species, it have more accurate area maps only recently been compiled.* The taxonomical statements are here and there out of date, but—since the authors are very concise in their statements, these are only sometimes relevant to the maps. Rarely incorrect names (for example, *Trinia kitaibelii* or *Heracleum sphondylium* ssp. *sibiricum*), or inaccurate information occur (for example, *Odontites vernus* 2n : 20 and ssp. *serotinus*, are correctly interpreted as *O. vulgaris* 2n : 40 separate species); of course, there are several obsolete or incorrect names, sometimes it is remarked even by the authors that they do not use the legitimate name (for example, *Libanotis montana* instead of *L. sibirica*). Several names mainly in Part I are already outdated today which is acknowledged also by the authors. It is already unusual that recently discriminated genera are only exceptionally recognized (for example, *Pseudolysimachion*), but there is for example no *Avenula*, *Dactylorhiza*, *Chamaecytisus*, *Gentianella*, etc. Of course much more smaller mistakes could be mentioned as well, inaccurate maps (as I had mentioned previously) but they can hardly reduce the value of this unique, excellent work that evokes respect and esteem. I have to furthermore stress the effectiveness and instructive character of the maps which are nicely drawn and well reproduced. In summary the work of MEUSEL and co-workers, is the greatest undertaking in the whole literature of botany with respect to chorological plant geography.

R. Soó

V. MARKGRAF and H. L. D'ANTONI: Pollen Flora of Argentina. Modern Spore and Pollen Types of Pteridophyta, Gymnospermae, and Angiospermae. With a Spore Morphologic Key and Photomicrographs of the Genera of the Fuego-Patagonian Pteridophyta by M. A. MORBELLI, pp. 1—208, 43 plates. Tucson, Arizona. The University of Arizona Press. 1978. $ 9.50.

374 species of sporomorphs have been described, illustrated and keyed in this comprehensive Pollen Flora of Argentina.

The main purpose of this work is to aid the future paleo-palynologic investigations in southern South America which were hindered till now by the total lack of basic palynological

* JALAS—SUOMINEN: Atlas Florae Europeae. Helsinki. I. *Pteridophyta* (1972), 2. *Gymnospermae* (1973), 3. *Salicaceae—Balanophoraceae* (1976). Hungarian co-workers: Soó, R., the late KÁRPÁTI, Z., then TERPÓ, A.

information. It was first necessary to establish a reference collection of the recent pollen of Argentine plants. With the help of this, palinologists will be able to give more information for paleoecology, paleoclimatology and archaecology in the near future.

All the plant taxa described are given according to the four main geographic regions: the Amazonic dominion (subtropic forest of NW and NE Argentina), the Chaqueno dominion (xerophilous, deciduous forest), the Andean-Patagonic dominion (open grass or scrub steppe of higher altitudes), and the Subantarctic dominion (mixed Southern beech forest).

This plant geographic aspect of the pollen flora should be of special interest because of its application to fossil palynologic work in different vegetation provinces.

The content of the book is divided into four main parts:

1. The chapter of the Plant geographic Provinces, embraces the microspores of 374 species grouped according to the plant geographical regions and ecosystems from the subtropical forest, xerophilous deciduous forest, Patagonian shrub and grass steppe and Andean grassland to the cool *Nothofagus* forest of the Valdivian and Magellan districts shared with Chile. This involves practically the whole of Argentina from the North to the South geographically.

Even the application of this pollen flora is not limited to the Argentine territory because of the wide floristic range. For example the tropical pollen types of northern Argentina have a geographic distribution throughout all the tropics of the New World. So, the collection of pollen types described here is very useful for palynologic works in other countries, in the same vegetation zone where these plants can be found.

2. The second chapter, Description of Spore and Pollen Types, gives the pollen morphologic description of each taxon identified, thus the character of aperture, the sculpture type, size measurements, exine thickness, pore and colpus characteristics. In the end, the geographical description of the collection site of the plant, the collector and the date of collection follow. Both the pollen descriptions and their photomicrographs are in alphabetical order by family — first *Pteridophyta*, then *Gymnospermae* and *Angiospermae*.

3. In the third chapter the Pollenmorphological Keys are involved. It is an unusual but very practical way not to make the keys of the complete list of species but divide them into four groups according to the main plant geographical regions as in chapter 1.

The author's aim was to make the palinological work much easier on fossil material in different vegetation provinces. Even in the case of fossil palinologic work done in plant geographic border situations, it is easier to use two pollen keys than the key of a big list of all species.

4. In the end we find the Key to the Genera of *Pteridophyta* of Fuego-Patagonia (M. A. Morbelli). It includes the morphologic key of 28 spore types with photographs.

Finally, three complete alphabetical indexes are provided to help find the taxa: thus, the index of all the species and families, then a plant family index in which all the species is listed under their family, and a common name index. In every case throughout the book, species are accompanied by numbers referring to plate and species number making the book very easy to handle. According to the authors (page 2) a letter symbol should accompany the species in the alphabetical species index marking the corresponding plant geographical region for each taxon. Unfortunately, it is missing from the book.

If the plants selected for characterization of different vegetation provinces and ecosystems are correct, the application of this selection will be very useful for fossil palinologic works.

M. Járai-Komlódi

Oberdorfer, E., Süddeutsche Pflanzengesellschaften. 2nd ed. II. VEB G. Fischer, Jena 355 pp. 76—138 charts. 44. — DM.

I have already reviewed the first part of Oberdorfer's monograph, in Acta Bot. Hung. 175 (1978) and in Bot. Közl. 65, (1978). What has been written there is valid for the second part — the authors of which are Korneck, Müller and Oberdorfer — as well. The classes elaborated in this volume are: *Sedo-Scleranthetea* (acidophil grasslands, rock- and elastic rock vegetation), *Festuco-Brometea* (dry and lowland grasslands, with basiiphil character), *Carici rupestris-Kobresietea* and *Seslerietea variae* (alpine grasslands), *Juncetea trifidi* (acidophil alpine grasslands), *Nardo-Callunetea* (heaths), *Trifolio-Geranietea* (fringe-associations) *Epilobietea angustifolii* (vegetation of cutting area), *Betulo-Adenostyletea* (subalpine scrubs). In opposition to, Hungarian researchers (especially the repeatedly quoted Jakucs, whose view is however kept in silence), the forest margin associations are categorized in a separate class. There occur only a few associations that are common to the Hungarian plant

cover, mainly of *Epilobietea*. The use of some group names (*Festucion pallentis*, *F. valesiacae* "KLIKA") for Western associations can hardly be considered as correct. Incidentally, the authors draw a very narrow line for the notion of associations, but subordinate units do not occur. The especially concise work is significant also for Hungarian plant cenology.

R. Soó

H. WALTER: Die ökologischen Systeme der Kontinente (Biogeosphäre). G. FISCHER Verlag, Stuttgart 1976. 132 pp. 63 pictures, 29. — DM.

I have on several occasions appreciated H. WALTER's pioneering and epoch-making work in geobotany and ecology, even in the part years (Acta Bot. **15,** 204—205 (1969); **21,** 28, 451 (1975); Bot. Közlem. **56,** 56 (1969); **62,** 38, 74, 216 (1975). He is the greatest master, doyen of classical synecology in Western-Europe.*

His present, last book adds to his smaller work on vegetation and climate (published in German and English in 1973), which is a concise summary of the book entitled 'Vegetation der Erde' (1968, 1973). His earlier publications were the 9 large climate diagrame maps of the continents (in co-operation with HARNICKELL and MUELLER-DOMBOIS, 1975, FISCHER, Stuttgart), and the Klimadiagramm-Weltatlas, compiled in co-operation with LIETH (1960—1967), which has been applied mainly by A. BORHIDI in our country. Here he has tried to the systematise the biogeosphere, that is, the terrestrial ecosystem, unfortunately with a rather clumsy terminology. (This is incidentally true also for the new Anglo-Saxon, authors and the Hungarian ones who are in their wake.) According to an English ecosystem definition (TANSLEY, Biol. Lexicon 3 : 299), the material and energy unit of nature is such a part of nature in which on the interaction of the inorganic environment and the plant- and animal associations, a permanent metabolism comes about between the organic and inorganic components. His interpretation however is, is quite diverse in practice; sometimes it means the complete living world of certain climate zones (see below WALTER's zonobiom), at others only that of very small ecotopes (wood-trunk, a single reed, leaf surface). Biogeosystem is a term frequently used in this country; often it refers only to certain biocenoses; I have always tried to avoid it. SUKATCHEW's biogeocenosis is a similar motion, with a narrower delimination, with the animal world, soil, micro-climate and water supply, etc. of one single plant association, the formation of which is the result of a counter-effect among its components; these constitute homogeneous complexes. With WALTER, the biogeocene also represents an actual plant association, which is divided into synusia, and which can form complexes and ecological series (which are often not identical with the succesion series), catena, etc. In recent years, WALTER uses the notion of biom originating from America (WHITTAKER's school), which is a large ecological unit of the environment and the biotic components together, and which is divided by him into further, more accurate notions; zonobion is the greatest unit, in accordance with the 9 ecological climate zones: 1, equatorial jungles (without seasons, with day-periodical climate); 2. deciduous forests, with tropical summer rains; 3. subtropical, dry (desert) forest; 4. forests with humid winters, arid summers, and of hard foliage; 5. warm, moderate, oceanic, evergreen forests, 6. deciduous forests with typically moderate short freeze periods, called nemoralis forests by Walter; 7. continental steppes with arid-moderate, cold winters; 8. boreal, coniferous woods with cold-moderate, cool summer; 9. arctic-antarctic climate zones, tundras. — Zonobioms are characterized also by zonal vegetation and soil types as well. Similarly to CLEMENTS, who named the transitional zones describes zono-ecotones (often with extrazonal (vegetation): 1—2: transition between jungles and deciduous tropical forests; 2—3: savannah; 3—4: semi-shrubbery; 4—6: sub-Mediterranean forest; 5—6: semi-evergreen forest of moderate climate; 6—7: forest steppe; 6—8: mixed forest or mosaic forest; 7—8: poplar-birch forests; 8—9: forest tundra. (In a very simplified survey.) The orobioms of the vertical climate zones of the mountains fall outside the zonobioms, and so do the extrazonal or azonal pedobioms, justified by the soil as the litho-, psammo-, halo-, hydro- and peinobioms; the latter in soils poor in nutrient.

* He was born in Odessa, 1898; Prof. univ. 1932, emer. 1966. He travelled across Africa (five research journeys) the Near East, Australia, South America (two journeys). His knowledge of Russian made it possible for him to elaborate the vegetation of Eastern-Europe, North and Central Asia several times (reviewed in 1975). His aims were to present a modern picture of the vegetation of the earth, on a pragmatic, eco-physiological basis (reviewed in 1969). He introduced the notion of hydrature, the most known are his climate diagrams. I met him in 1928 at the IPE; he also came to our country at that time.

The term biom is used for ecosystems of smaller volume (areas, geographical units, individual mountains, etc.), which is rather uncertain in this way. The synecological system based on formations (the latest is by MUELLER-DOMBOIS and ELLENBERG 1974) is — justifiably — rejected by WALTER. He emphasizes that in the ecosystem, the circulation of material, the path of energy, and the phytomass depend on the dominant species, while the characters are irrelevant, although they assist in recognizing of the associations. I myself have often emphasized that the purely statistical (computer) results are of no value, since the accidental elements represent identical values with the dominants and the characters. However, this will be dealt with in more detailed elsewhere.

Of the chapters discussing the examples, one deals in detail with a biogeocenosis, forest-steppe-forest (*Tilio-Quercetum aegopodiosum*) — besides Worskla (a monograph by GORYSINA and co-workers, 1974) — mainly from ecophysiological and production-biological viewpoints; and with a biom; this is a discussion of the vegetation of the sand-desert Karakum; the latter is based on numerous soviet authors, mainly on NETCHEVA and co-workers, 1975). (I should remark that I myself also had the opportunity of becoming familiar with a few plant associations of the Karakum and Kizilkum deserts, in 1976.) We are more closely interested in that he determined in the Pannonian-Dacic area a triangle-ecoton, viz. the interception of the Central-European ("nemoral") forests, the steppes, and the sub-Mediterranean forests (on the basis of the work of HORVAT—GLAVAĆ—ELLENBERG 1974), with a semi-arid forest-steppe climate and macromosaic structure. This has been known in Hungarian literature for a long time; when reviewing the text of the vegetation map of HORVAT and co-workers, I criticized (Acta Bot. Hung. *20*, 206, 1974) that they attribute this thesis to the results of their own examination; now the book does already enumerate references of a rich Hungarian literature up to 1970 and emphasizes that I was the first to make the statement of foreststeppe (Steppenwald) in my study of 1926 (p. 277). WALTER however opposes the nomenclature of BORHIDI and SOÓ (1962—1965) in relation to the Illyrian beeches — p. 415 — even though it is a consequence of the rule that the independent associations are to receive two-fold names and not geographical titles (as have been given by the Jugoslavian authors).

WALTER is right to pronounce (p. 50) that an ecologist can carry on his measurements and studies only in real ecosystems and not on abstract models, as is regretfully common with certain authors in our country (considering the laboratory and field work of our synecologists as valueless and laugh at it).

The 80-year-old author's life work can only be praised with honour and esteem.

R. Soó

DYKYJOVA, D., KVĚT, J. (eds) 1978: Pond Littoral Ecosystems, Structure and Functioning. Methods and Results of Quantitative Ecosystem Research in the Czechoslovakian IBP Wetland Project, SPRINGER Verlag Berlin, Heidelberg, New York, pp. 464, 183 figures.

The results of the Czechoslovakian IBP Wetlands Project are summarized in this book. The 27 authors carried out intensive quantitative ecological investigations, beginning in 1965, on shallow littoral ecosystems of typical Central European fishponds. These are small man-made water bodies managed century long for fish production.

In the introductory part the authors frankly tell us: "The volume does not present a final synthesis in the form of overall ecosystem budgets and models, but the editors have attempted to give as much as possible of condensed quantitative data as is needed for syntheses and ecosystem modeling. With respect to the present state of knowledge on the ecology of freshwater wetlands, such a point of view is probably more profitable for the reader than any sophisticated and refined models supported by an insufficient amount of sound data." This argumentation is lame since the setting up and the presentation of a model does not exclude the collection and publication of data in appropriate numbers. It is much more the case that the 'break-through' in ecological approach could not be accomplished. Essentially, the project did not attain its final goal, the setting up of a comprehensive ecological model. This is all the more regrettable because the attainment of such an aim beyond its scientific importance, would have a great practical significance as well, in an ecosystem which is utilized and intensively managed by man. Irrespective of this shortcoming, the book contains very important results, and Hungarian hydrobiologists would also be very happy if they know so much about their fishponds.

The book consists of eight main chapters: General ecology and inventarization of biotic communities; Environmental factors in fishpond littorals; Primary production processes in littoral plant communities; Structure and functioning of algal communities in fishponds;

Decomposition processes in the fishpond littoral; Structure and role of animal populations in fishpond littorals; Effect of a fishpond management on the littoral communities; Conservation of plant communities and waterfowl in wetlands of Czechoslovakia. Chapter Three is probably the most well-elaborated part of the book; regarding its volume it is also the largest among the others. Here even a model is given on the CO_2 uptake and respiration in the dark of a *Phragmites* stand. The use of the name *Phragmites communis* is striking conservatism when it was as early as ten years ago that *P. australis* was reported in the Taxon as the valid name for common reed. The lists of references given at the end of the various chapters call the attention of the international public opinion to such works containing very valuable results, and which must owing to various reasons have been overlooked so far.

I can highly recommend the work to every hydrobiologist.

L. HAJDU

KREMER, J. N., NIXON, S. W. (1978): A coastal marine ecosystem. Ecological studies 24, SPRINGER Verlag Berlin, Heidelberg, New York, p. 217.

The two young professors (resp. 33 and 35 years old) produced not merely a simple numerical model of with respect to Narragansett Bay, but an aid to a better understanding of the ecosystem of the area and the construction of new hypotheses.

In the Preface the authors point to the differences in view of the modelling specialists and of the biologists, and they hope to be able to bridge over the gap existing between the two points of view. Let us quote a part of the Preface: "... much of the modelling literature is very theoretical and appears to be concerned more with the behaviour of differential equations than with living systems. It is difficult for the practising biologist or ecologist who measures metabolic rates, or nutrient kinetics, or feeding patterns, to relate this efforts to equations with a few highly aggregated coefficients."

In the Chapter entitled Evolution of Ecosystem Models, a short survey, revision is provided on the history of mechanistic models. Then the authors describe the process of constructing their own model. This always begins with the observation and description of the real world. Narragansett Bay is a temperate, plankton-based marine ecosystem; the well-mixed water column and the relatively constant salinity are characteristic for it. The model is concerned largely with a mechanistic numerical description of phytoplankton-zooplankton-nutrient dynamics, and the ways in which these dynamics are influenced by light, temperature and hydrography. Bacterial decomposition and regeneration are simulated entirely through empirical regressions relating not rates to temperature. The six state variables are: phytoplankton, herbivorous zooplankton, ammonia, nitrate-nitrite, phosphate and silicate. The authors present a detailed description of the model equations and of the theoretical considerations on the basis of which the model equations have come about—this part comprises the essence of the book. By the mathematical formulation the authors were not searching for new solutions, but an appropriate interpolation of the versions already published for. The computer programme is described in such detail that if somebody has already acquired some basic knowledge of computer techniques he will be able to understand it. It is just this feature of being easily understandable which is missing from the literature on modelling. The book is closed by an analysis of the model. Here it is not only that the functioning behaviouring of the system produced by means of the equations is simply described but also the background biological bases are detected. Finally, and 11-page list of references is provided.

The book is not merely an appropriate case study but a textbook of ecological modelling well illustrated with examples.

L. HAJDU

MONTEITH, J. L. ed: Vegetation and the atmosphere. Academic Press London—New York—San Francisco, Vol. I. 1975. pp. 278 and Vol. II. 1976. pp. 439.

With the appearance of this book a great gap has been filled in plant ecology. The positive effect of micrometeorology can be well perceived in plant ecology. The most important merit of the book is that it has brought the two branches of science closer at a higher underdisciplinary level. Those concepts and measurements of micrometeorology which deal with the essential problems of plant ecology are discussed and both micrometeorological and plant ecological experiments are presented. Famous micrometeorologists and plant ecologists answer the question what the present state of micrometeorology and plant ecology is, how these branch-

es are connected nowadays, and some prediction is made on the future of the micrometeorological and biological approach. Moreover the most important theoretical and empirical results are summarized with a forecast of the unsolved problems to come into prominence in the near future.

This work consists of two volumes. The first deals with basic principles and the second with case studies of different crops, forests and ecosystems.

Volume I.

The introductory chapter of the first volume makes a short survey and comparison between the methods of micrometeorology and plant ecology. The following four chapters deal with transfer processes.

The chapter entitled "Radiation transfer in plant communities" deals with various radiative problems of the community, such as optical properties, penetration of the direct and diffuse solar radiation, total and reflected radiation, radiation regime, spectral composition of the radiation, long-wave and net radiation. Thereby a detailed theoretical picture is presented of the most decisive ecofactor, radiation, in the community.

The next chapter deals with mass, heat and momentum transfer. It's main theme centers around the question of momentum transfer as a primary process, the aerodynamic treatment of mass and heat transfer and the energy balance approach.

The fourth chapter is concerned with the hydrological cycle in vegetation an emphasis on the interrelation of the soil-plant-atmosphere.

Chapter V. discusses the movement of particles in plant communities, analysing the airtransport and deposition of spores and pollens, and their effects. The study is a very interesting summary of vegetation investigations of this kind. Furthermore it is indicated how the conceptions described in the earlier chapters can be used as mathematical models e.g.: for growing of vegetation or for water-utilization. The closing chapter of the first volume describes the micrometeorological appliances used in plant ecology, the calibration and their utilization.

Volume II.

The second volume consists of 13 studies which apply the basic principles described in Volume I. to actual plant-ecological cases.

The first five chapters give us a picture about the micrometeorology of different agricultural crops, such as temperate cereals, maize and rice, sugarbeet and potatoes, sunflower and cotton. In addition radiation, heat and water, carbon-dioxide as well as of transfer processes within crops are examined in detail. The sixth chapter entitled Townsville style (*Stylosanthes humilis*) includes the analysis of tropical annual legumes. It shows the micrometeorological examination during the main growth period, it's growth models and the ecology of pastures. In the following three chapters the most important elements of micrometeorology of different forest-types, such as about (coniferous forest, deciduous forest and tropical rain forest) are dealt with. Exchange and turbulence of carbon-dioxide are the main concern of the chapter with respect to the tropical rain forest. In this chapter we are given a model of carbon-dioxide exchange and the simulation of carbon-dioxide exchange. Chapter X. is about the examination of micro-environment of citrus orchards, frost protection in citriculture, and about means of controlling the solar radiation climate in citrus orchards.

From the three last chapters we get to know how micrometeorological conceptions can be applied to whole ecosystems in concrete cases taking as examples swamps, grasslands and tundres.

Well-selected and plentiful references are given at the end of all the studies.

Using standard units and symbols in all studies of the two volumes especially to be appreciated, because it always causes problems in a book written by more than one author. But the absence of agreed units and symbols delayed comparing and discussing on the merits of the scientists' results who study this part of biology. This fact and the compilation of the whole book testifies also to J. L. MONTEITH's excellent editorial work. The tables and figures are logical and comprehensible. The book's typographical lay-out is also to be praised.

It is a most efficient book of equal importance for forestry engineers, agriculturalists, researchers from other branches of science as well as students. and not in the least it can be highly recommended to ecologists who are to solve the most urgent problems of ecology.

Z. TUBA

SAVAGE, J. M.: Evolution. Third edition. New York, etc. 1977. HOLT, RINEHART and WINSTON, Modern Biology Series. — V + 184 pp.

Since anniversary decade of the DARWIN centennary at least a dozen large handbooks and monographs have been published on the biological evolution, from the writings of the most excellent specialists of the topic. Their enumeration is superfluous here. Although all of them approach the basic questions of evolution from different aspects they agree in that the past and present seemingly infinite multifariousness of the living world and the unestimable evolutionary potential are the consequence of the interaction of the biological and abiological factors.

A great number of publications, propagating knowledge on a smaller scale of the same questions, and university textbooks as well as synopses serving the post-graduate training of researchers, appear every year. These publications, owing to their short volume, are necessarily sketchy, which in itself would not be a problem; however, many of them oversimplify the questions of evolution by avoiding the problems, which however is a serious shortcoming.

It is not without reason that SAVAGE's small book to be reviewed here has reached its third edition: it is not oversimplified, and yet readily comprehensible. In the introductory part, he demonstrates the universality of the basic characteristics of the living world by outlining the molecular biological fundamentals, then the contemporary diversity is presented by a short paleontological survey.

The subject of the second part is the description of the basic processes of evolution; the genetical bases; the main evolutionary driving forces; the sources of variation. The role of natural selection, and genetical drift, as well as the adaptational interactions of the evolutionary forces are described in brief, but from many aspects and vividly. Even though he makes a differentiation between micro-, macro-, and mega-evolution, he emphasises that the evolutionary driving forces are the same at all levels: selection, isolation and drift, but their interactions and intensity vary in case and in time.

From the recent ideas on the origin of life on earth, then a few results of experimental approaches, he switches over to the very exciting problems of the evolution of human apprehension and consciousness. A glimpse of the perspectives of mental evolution, the necessity and possibilities of a better recognition of man himself ends the book, which is excellent illustrated written in a thought provoking style of high standard, with ample information and is worth reading.

B. JANKÓ

INDEX

HUMAN IMPACTS ON LIFE IN FRESH WATERS

Ed. by J. Salánki and P. Biró

(Symposia Biologica Hungarica 19)

The present volume includes the lectures presented at the Symposium on Human Impacts on Life in Fresh Waters organized by the Biological Research Institute of the Hungarian Academy of Sciences, Tihany, between 7—9 September 1977.

The 19 papers by experts from ten countries cover a wide range of limnological, toxicological, physiological and hydrological studies. The volume deals with the cultural euthrophication of fresh waters, the relationships of aquatic plants and animals, and the changes in ecosystems due to human impacts. A major part of the volume has been devoted to the biological effects of pollution of different origin in fresh waters, to their intensity and type and also to the prediction and prevention of their deleterious consequences.

Effects of pollution to the environment and impacts of commercial fisheries on fish fauna or a given fish population are treated in detail both in rivers and stagnant waters. Some effects of various toxic compounds on the physiological functions of fresh water invertebrates are also described.

The volume can be recommended to all those interested in general or special problems of limnology, i.e. to experts of ichthyology, botanics, zoology, hydrology, toxicology and environmental protection.

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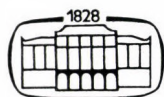
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ИССЛЕДОВАНИЕ СООТНОШЕНИЯ РАЗЛИЧНЫХ ПО ДЛИНЕ КЛЕТЧАТКИ ГРУПП У НЕКОТОРЫХ ДРЕВЕСНЫХ ВИДОВ КУБЫ

К. БАБОШ

Автор исследовал по параметру длины клетчатки 15 древесных и кусатрниковых видов Кубы. Изучались следующие виды: *Curatella americana* L., *Calophyllum antillanum* Griseb., *Guanuma ulmifolia* Lam., *Luehea speciosa* Willd., *Alvaradoa amorphoides* Liebm. ssp. *psilophylla* (Urb.) Cronq., *Guarea guidonia* (L.) Sleumer, *Trichilia hirta* L., *Cyrilla racemiflora* L., *Cupania glabra* Sw., *Lysiloma bahamensis* Benth., *Myrsine cubana* A. DC., *Mastichodendron foetidissimum* (Jacq.) Cronq., *Linociera bumelioides* Griseb., *Cordia sebestena* L., *Quercus oleoides* Cham. et Schlecht. ssp. *sagraeana* (Nutt.) Borhidi. С целью сравнения проводилось также исследование двух европейских видов: *Quercus cerris* L. var. *austriaca* (Willd.) Loud. и *Populus alba* L.

ИЗУЧЕНИЕ СТРУКТУРЫ ПЛАНКТОННОГО СООБЩЕСТВА НА ОЗЕРЕ ВЕЛЕНЦЕИ

Ж. БАРТА, Л. ХАЙДУ

Авторы исследовали состав и количество видов фитопланктона в различных по своей трофичности местах озера Веленцеи. Авторы определили 242 таксона, из которых 118 новые для озера. Из полученных данных при помощи формулы SHANNON было высчитано распределение. На основе методических исследований авторы предлагают для изучения распределения фитопланктона оптимальный метод общего количества особей (ОКО), описание которого дается в этой статье. Авторы определили, что редкие виды не влияют на оценку распределения. Распределение растительного планктона, собранного в трех местах озера Веленцеи уменьшается в следующем порядке: Фюрдете, Луг—Немфоги, Галлер. Фюрдете, в котором протекает два водозагрязненных ручья, в 1972 году был один из излюбленных мест для планктонных водорослей. Это можно обяснить тем, что поступающие растительные питательные вещества увеличивали распределение фитопланктона в Фюрдете. Рост питательных веществ в последующие два года вызвал сильное понижение распределения. По мнению авторов максимальная кривая эитрофизации влияет на распределение.

ВОСТОЧНО—АФРИКАНСКИЕ БРИОФИТЫ III.

М. БИЗО, Т. ПОЧ

В работе опубликованы экологические и бриогеографические данные более, чем о 300-ах видов мхов, а также таксономические замечания и данные по их распространению. Большая часть материала была собрана Т. Поч, в горах Восточной Африки, в Танзании, а меньшая часть была собрана другими сотрудниками. Одна часть упомянутых видов новая для Восточной Африки, а некоторые новые для всего континента. Таксономическую ревизию провдил Т. Поч (*Hepaticae*, *Bryum*, а также для генуса *Rhodobryum*, а также Бизо (различные *Musci* и в особенности генус *Fissidens*). Авторы предлагают следующие новые названия *Frullania vanderberghenii* Pócs nom. nov., *Lejeunea tuberculiflora* E. W. Jones ex Pócs nom. nov. и новые комбинации: *Lophocolea muhavurensis* (S. Arnell ex Pócs comb. nov., *Fissidens enervis* Sim. ssp. *hedbergii* (P. Varde) Bizot comb. nov., *Fissidens diaphanodonta* (P. Varde) Bizot comb. nov., *Rhodobryum perspinidens* (Broth.) Pócs comb. nov., *Rhodobryum spathulatum* (Hornsch.) Pócs comb. nov.

ФИТОЦЕНОЛОГИЧЕСКАЯ КЛАССИФИКАЦИЯ РАСТИТЕЛЬНОСТИ КУБЫ

А. БОРХИДИ, О. МУНИЗ, Е. ДЕЛ-РИСКО

Авторы в течении 10 лет изучали физиогномическую структуру и ценологический состав растительности Кубы. Былии определены различные по рангу группы вегетации. В результате этих исследований авторы публикуют впервые собранный в порядок обзор о более высоких фитоценологических особях кубинского растительного покрова, а также их краткое описание. Обзор содержит в себе 27 классов-ассоциаций, из которых 14 новые для науки (*Salvinio-Eichhornietea*, *Cabombo-Nymphaeetea*, *Sesuvio-Rhachicallidetea*, *Chrysobalano-Annonetea*, *Sabalo-Roystonietea*, *Coccolobetea uviferae*, *Phyllantho-Neobracetea*, *Pachyantho-Pinetea*, *Ocoteo-Magnolietea*, *Clusio-Ilicetea Parvirhynchosporeto-Eriocauletea*, *Curatello-Byrsonimetea*, *Byrsonimo-Pinetea*, *Caseario-Pinetea*, *Rondeletio-Gesnerietea*), далее 53 порядков-ассоциаций и 80 федераций-ассоциаций. Авторы коротко описали физиогномию и экологию ценологических групп, а также характерную комбинацию видов, а также перечисляют 186 самые главные ассоциации.

ЦИТОХИМИЧЕСКОЕ ИЗУЧЕНИЕ ТОЧКИ РОСТА СТЕБЛЯ ЯБЛОНОВ. II. СОДЕРЖАНИЕ ДНК В ЯДРАХ КЛЕТОК МЕРИСТЕМЫ И РОСТ СТЕБЛЯ В ЗАВИСИМОСТИ ОТ НАПРАВЛЕНИЯ РОСТА СТЕБЛЯ И ОБРАБОТКИ ЕГО МОРФАКТИНОМ

Т. БУБАН, Ц. У. ХЕСЕМАНН

Данная статья дает информацию о замеченных при фотометрическом измерении изменениях уровня ДНК в ядрах клеток точек роста стебля, обработанного ниже описанным образом. Авторы изучали стебли в их естественном положении: вертикальном (V), горизонтально (H) или вертикально растущие, но привязанные в горизонтальном направлении (VH). Некоторые части стеблей (V, H, VH) были обработаны морфактином. Образованию цветковой почки помогает горизонтальное привязывание стеблей, а также обработка их морфактином. В точке роста стеблей привязанных горизонтально содержание ДНК выше, чем в стеблях растущих вертикально. Внутри стеблей горизонтального положения в части находящейся по направлению к земле уровень ДНК намного выше. А обработка морфактином в некоторой степени понижает содержание ДНК и уравнивает разницу между нижней и высшей стороной горизонатльно растущих точек роста.

ИЗУЧЕНИЕ СВЕТА И ФОТОСИНТЕТИЧЕСКИХ ПИГМЕНТОВ У ВИДОВ ТРАВЯНИСТОГО ЯРУСА БУКОВЫХ ЛЕСАХ

М. П. ДРАШКОВИЧ

Автор проводил измерение освещения листьев видов у грабовых буковых *Melitti-Fagetum* на травяном ярусе, и определил содержание и концентрацию фотосинтетических пигментов (хлорофилл а и б, каротиноиды) — в соответствии с аспектами и временами года — у листьев доминантных видов, растущих на травяных ярусах. Ранневесенние геофиты живущие в периоде богатым светом *Anemone ranunculoides*, *Dentaria enneaphyllos*, *Corydalis bulbosa* обладают более высоким уровнем пигментов, большой пропорцией хлорофилла а и б. У травянистоярусных гемикриптонных видов *Oxalis acetosella*, *Galium odoratum*, *Viola silvestris*, *Carex pilosa* концентрация пигментов в более хорошо освещенные периоды ниже, а в менее освещенные летние месяцы выше. Летом в условиях равномерного освещения в популяциях различных видов концентрация пигмента одинакова. Соотношение а/б хлорофилла целый год очень низкое, и светоэкологически закреплено.

НОВЫЕ ВОДОРОСЛИ В ВЕНГРИИ

Т. ХОРТОБАДИ

Автор в 1970—76 гг. проводил исследования водорослей в Будапештской части Дуная и в системе Будапештских очистительных сооружений, поставляющих питьевую воду.

Описано 26 новых для науки таксонов. Среди них 8 новых видов, 7 подвидов и 11 новых форм. Также описывается один новый род.

Новые таксоны следующие: *Pelodictyon clathratiforme* (Szafer) Geitler f. *maius* Hortob. f. n., *Trachelomonas gregussii* Hortob. var. *danubialis* Hortob. var. n., *Chlorogonium elongatum* Dang. var. *gigas* Hortob. var. n., *Pteromonas danubialis* Hortob. sp. n., *Actinastrum ellipsoideum* Hortob. sp. n., *A. hantzchii* Lagerh. var. *curvatum* Hortob. var. n., *Burkillia cornuta* W. et W. f. *minor*, Hortob. f. n., *Chodatella ciliata* (Lagerh.)Lemm. f. *crassa* Hortob. f. n., *Ch. quadrangularis* Hortob. sp. n., *Ch. robusta* Hortob. sp. n., *Crucigenia laxa* Hortob. sp. n., *Didymocystis inermis* (Fott) Fott var. *danubialis* Hortob. var. n., *D. inermis* var. *danubialis* f. *simplex* Hortob. f. n., *Didymogenopsis* Hortob. gen. nov., *D. danubialis* Hortob. sp. n., *Heleochloris conica* Korsch. f. *minor* Hortob. f. n., *Kirchneriella irregularis* (Smith) Hortob. var. *danubialis* Hortob. var. n., *Lagerheimia genevensis* Chod., f. *crassiseta* Hortob. f. n., *L. genevensis* f. *granulata* Hortob. f. n., *L. genevensis* var. *spinosa* Hortob. var. n., *L. genevensis* var. *subglobosa* (Lemm.) Chod. f. *crassiseta* Hortob. f. n., *L. wratislawiensis* Schroed. f. *flexocaudata* Hortob. f. n., *Tetraëdron caudatum* (Corda) Hansg. var. *depauperata* Printz f. *granulatum* Hortob. f. n., *Tetrallantos gracilis* Hortob. sp. n., *T. scenedesmoides* Hortob. sp. n., *Tetrastrum heteracanthum* (Nordst.) Chod. var. *crassisetum* Hortob. var. n., *T. tenuispinum* Hortob. f. *irregulare* Hortob. f. n.

ПРОСТРАНСТВЕННЫЕ ПРОЦЕССЫ В ПЕСЧАННО-ТРАВЯНИСТЫХ СООБЩЕСТВАХ. I. КОЛИЧЕСТВО ВИДОВ, КОЛИЧЕСТВО ОСОБЕЙ, ПОКРОВ И БИОМАССА НА УРОВНЕ СООБЩЕСТВА

Е. Н. МОЛНАР, Я. Н. НОСЕК

Авторы изучали некоторые свойственные для сообщества изменения (количество видов, количество особей, покрытие, живую и мертвую фитомассу) в различных сезонных аспектах, в зависимости от нарастания площади (от 0,04 до 1 м²) песчанно-травянистого сообщества. Взятие образцов происходило случайно квадратами, независимыми друг от друга.

Изменение числа видов и числа особей хорошо отражали изменение аспектов сообщества. Летние оценки были самые низкие (присутствие видов, приспособленных к условиям семи-арид). Покрытие не показало систематическую связь с аспектами. Количество живой фитомассы росло от весны до осени. Все исследованные характеристики, за исключением мертвой фитомассы осенью достигали максимального значения.

Количество видов изменилось логарифмически в зависимост от роста площади в каждом сезоне. Между всеми остальными характеристиками и ростом площади можно было определить позитивную линеарную зависимость. Авторы определили также процентные отклонения между данными, измеренными и рассчитанами на 1,0М². Сравнивая сезонные изменения с изменениями показанными в зависимости от площади, регрессионные прямые показали самую малую и самую большую крутость в том году, в котором абсолютная оценка характеристики также была минимальная, вернее максимальная.

Можно было определить положительную линеарную зависимость среди различных пар исследованных характеристик. Крутость регрессионных прямых в различные времена года показали отклонения.

ДАННЫЕ О РЕПРОДУКТИВНОЙ СПОСОБНОСТИ QUERCUS CERRIS L.

М. НАДЬ

Работа содержит данные 1977—78 гг, о репродуктивной способности *Quercus cerris* L. в естественных условиях на территории Шикфёкут-Project.

Исследования проводились на 6 га лесного участка под 50 деревьями на фиксированных площадях в 1 м², где определялось количество опавших желудей и количество развивающихся из них саженцев, живущих в течение года.

Установлено, что репродуктивная способность равна $C_r = 19{,}1\%$, что соответствует $\bar{C}_r = 17{,}86$ шт (м²) 10 месяцев.

Гибель саженцев равна $\Gamma = 44{,}88\%$, в то время как средняя гибель равнялась $\bar{\Gamma} = 14{,}54$ шт (м²) 4 месяца.

Значительная часть (46,3%) урожая попадает в почву уже поврежденной насекомыми. Большое количество желудей (47,8%) истреблялось крупными и мелкими млекопитающими. Среды начавших развиваться плодов 73% опадали незрелыми и неразвитыми.

НОВЫЕ ДАННЫЕ К ФЛОРЕ ПЕЧЕНОЧНЫХ МХОВ ЛАТИНСКОЙ АМЕРИКИ I.

Д. М. РЕЙЕС

Автор описывает 26 редких таксонов печеночных мхов из Латинской Америки, большей частью на основании собственного материала, а также из коллекции HAC и EGR. Среди перечисленных видов 6 новые для Кубы: ***Aphanlejeunea ephemeroides*** **Schust.**, ***Colura greig-smithii*** Jov.-Ast, *Colura tenuicornis* (Evans) Steph., *Drepanolejeunea lichenicola* (Spruce) Steph., *Prionolejeunea helleri* Evans, *Radula pallens* (Sw.) Dum. А остальные 3 вида новые для других стран Латинской Америки.

НОВЫЕ НАЗВАНИЯ В РОДЕ OPHRYS

Р. ШОО

Автор описывает 4 новые комбинации и 4 новых гибрида из рода ***Ophrys***, а также дает некоторые критические таксономические замечания. Новые комбинации: ***O. oestrifera*** Fleischmann var. *fleischmannii* (Hayek) Soó, var. *dyris* (Maire) Soó, *O. tommasinii* Vis. ssp. *arenicola* (Rchb. f.) Soó, *O. kurdica* Rückbrodt ssp. *kurdistanica* (Renz) Soó. Новые гибриды: ***O. x gumprechtiana* Soó, *O. x waldmanniana* Soó, *O. x baumanniana* Soó, *O. x grafiana* Soó.**

ЗНАЧЕНИЕ АНАТОМИЧЕСКИХ ПРИЗНАКОВ В СИСТЕМАТИКЕ ВЕНГЕРСКИХ GENTIANA

Ю. СУЙКО-ЛАЦА, С. СЕН

Авторы изучали анатомию листа и стебля у трех венгерских видов ***G. pneumonanthe***, ***G. cruciata***, и ***G. asclepiadea***. На пять признаков у ***G. cruciata*** влияют окружающие условия, тогда как у ***G. asclepiadea***, и ***G. pneumonanthe*** только на два признака. Число папилярных клеток на краю листа также различалось у этих трех видов. Авторы нашли сигнификантную корреляцию у ***G. cruciata*** между главными сосудисто-волокнистыми пучками и внутренним влагалищем площади паренхимы, и между первыми боковыми пучками и внутренним влагалищем площади паренхимы у ***G. asclepiadea***. Длина устьиц имела более высокую величину множественности чем ширина устьиц. Авторы нашли целый ряд признаков которые были общие у всех трех видов, вернее общие для пары видов и которые в дальнейшем дают диагностическую оценку для отдельных видов. Как и ожидалось на основе морфо-таксономических исследований ***G. cruciata*** и ***G. pneumonanthe*** похожи по анатомическому строению стебля, а ***G. asclepiadea*** и ***pneumonanthe*** по анатомии листа. Это хорошо обосновывает обсуждение таксономии этих трех видов.

VARGAMYCES — НОВЫЙ РОД (HYPHOMYCETES), ЖИВУЩИЙ НА ПОДВОДНЫХ ГНИЮЩИХ РАСТИТЕЛЬНЫХ ОСТАТКАХ

Ш. ТОТ

Статья включает в себя описание вида и типа рода ***Vargamyces*** **nov. gen.** из ***Hyphomycetes***. Единственный вид нового рода обитает в водных и полуводяных биотопах.

АНАТОМИЯ ЦВЕТУЩЕГО CORYDALIS BULBOSA (L) PERZ. И ЛОКАЛИЗАЦИЯ АЛКАЛОИДОВ

П. Г. ВЕРЗАР и П. Т. МИН ХОАНГ

Авторы изучали и дали характеристику тканей клубня, стеля, листьев, цветов, а также зеленого и зрелого плода *Corydalis bulbosa.* Было определено, что имеются группы, состоящие из одной, а также 3 – 4 клеток из которых образованы собиратели выделений, очень характерные. В клубне имеются паренхиматические элементы, которые содержат много крахмала. Для стебля характерны коллатеральные пучки. У листьев можно выделить групповые жидатоды. Для внутренней стенки стенки плода характерны образование папил. Гистохимические исследования показали на локализацию алкалоидов в стенке клетки, между клетками и в собирателях выделений.

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